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February 7, 1929

Engineering News-Record

Devoted to Civil Engineering and Contracting

ANNUAL
SURVEY OF ENGINEERING PROGRESS

From the foreword of this issue:

"ONE of the busiest years of construction history has closed and another of equal promise has begun. A favorable construction outlook portends an active year for engineers in both private and public undertakings — Definite progress is being made in many branches of the art — Work has begun with vigor on the Mississippi River flood-control enterprise, and the Boulder dam project is authorized — An engineer will shortly occupy the Presidential chair and will bring to his great task a sympathetic understanding of the problems which confront the nation and its industries — Closer relations are developing between the countries of the two Americas. The work of every engineer, whatever his sphere of labor, will be furthered by a thoughtful contemplation of these conditions."

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By Thaddeus Merriman

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By George A. Orrok

Fifty mechanical men serve each individual in this country. A survey of the influence of power upon industry and the home.

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ANNUAL SURVEY ISSUE

Contents

Volume 102, Number 6, February 7, 1929

An Editorial Survey 205

Some Construction Projects of 1928 221

Status of the Major Engineering Projects 238

The Construction Outlook 243

News of the Week 247

The Business Side of Construction 251

FOUR ARTICLES BY OUTSTANDING MEN ON SUBJECTS OF TIMELY INTEREST TO CIVIL ENGINEERS:

Dam Construction and Design 213

CURRENT PRACTICE seen as the expression of an art seeking the enlightenment of science. By Thaddeus Merriman

Power the Source of Modern Civilization 217

EXTENSION of its use until every person commands mechanical energy equivalent to that of 50 men. By George A. Orrok

Registration of Engineers 229

SURVEY made to answer question whether the plan has accomplished the expected results. By C. J. Ullrich

Aviation as a New Factor in Transportation 232

AMAZING PROGRESS in airports and airways, and in motive power problems and motor design. By W. G. Herron

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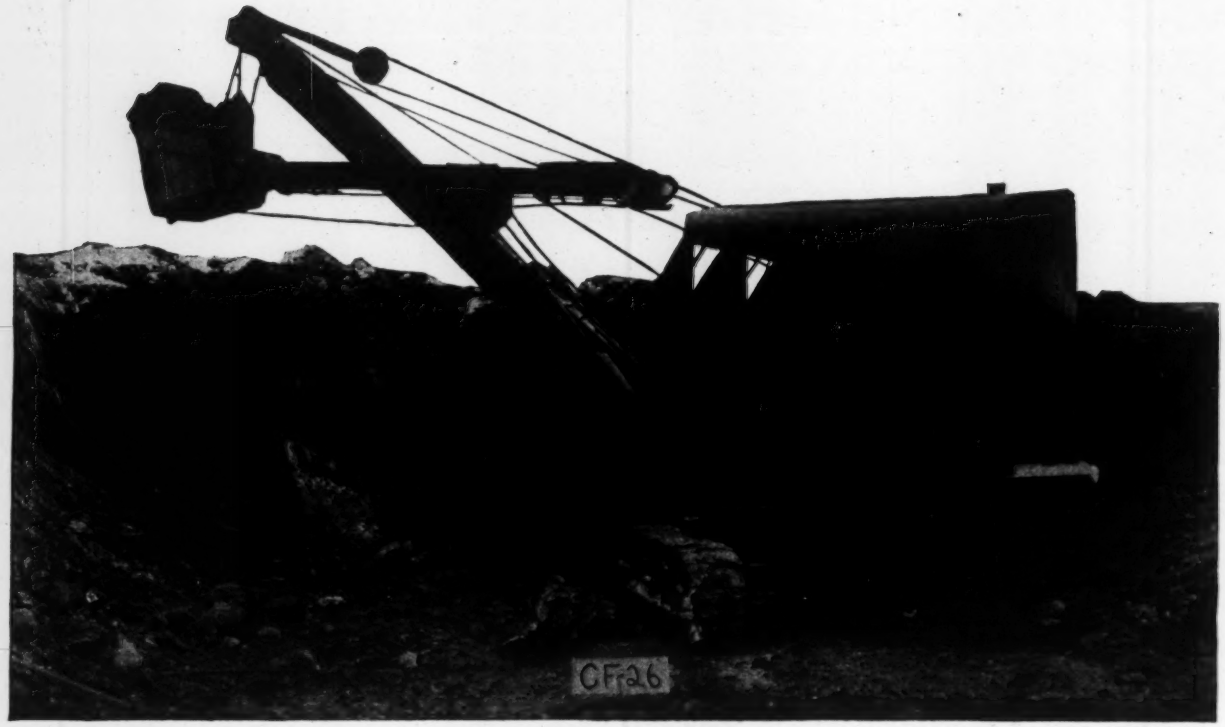

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Civil Engineering and Construction Progress

AN EDITORIAL SURVEY

IN ORDER to provide the engineer with some benchmark records for his survey of the present year's activities, this issue gives an outline of current progress in the art and industry. The broad facts of the situation are noteworthy and gratifying. One of the largest years of construction history has closed and another of even greater promise has begun. A wholly favorable construction outlook portends an active year for engineers in both private and public undertakings.

Definite progress is perceptible in many if not most branches of engineering science and art. Co-ordinately, the problems of planning and construction are becoming greater. Work has begun with vigor on the Mississippi flood-control enterprise, a momentous development for the Middle West, and the Boulder dam project, equally momentous for the Southwest, has been authorized. Other problems of equal or greater magnitude are approaching, but under the most hopeful conditions. The prospect is still more favorable because an engineer will shortly occupy the Presidential chair and will bring to his great task a sympathetic understanding of the difficulties which confront the nation and its industrial agencies. He may succeed also in fruitfully extending the interest of the United States in other parts of the Western world. Already closer relations are developing among the countries of the two Americas. The work of every engineer, whatever his sphere of labor, will be furthered by thoughtful contemplation of these conditions.

Sound Conditions

BOTH the volume of the work which enlists the engineer's art and the quality of that art itself are in sound condition. Of the nine billions of dollars that went into construction last year, 40 per cent was heavy or engineering construction; the current year will see this activity equaled. Ready financing and well-adjusted production capacity for supplying the worker with necessary materials and tools, together with harmonious labor conditions, are factors in the new stability which is holding industry and commerce at a base-level twice as high as that of the opening years of the decade or the pre-war period. The larger share which business is taking in preventing unsound practices from springing up or continuing helps to maintain that confidence and working spirit which enables every man to produce more than his bare necessities.

In due proportion to the rate at which efficiency is growing in all the practical arts, civil engineers and constructors also are developing their skill as well as their knowledge. Taking the past year as measure, scientific and technical advance is satisfactory. The art is becoming surer, and it is testing its data and assumptions ever more actively. In most departments of engineering industry the several products or elements of practice are standardized or made reasonably uniform as rapidly as advance of knowledge permits, by virtue of a progressive commercial attitude in which industrial co-operation is an element. Construction also is advancing, both by ingenuity and keen study of problems and by utilizing an improved armament of tools.

Significant Events

OF THE noteworthy events of the year, a smaller proportion than usual was due directly to Nature's vagaries. There were no great floods, and in particular the Mississippi was quiet. The Florida hurricane of September made a memorable record, bringing death to several thousand people by sweeping a great storm-wave over the southeast levees of Lake Okeechobee; one of its striking features was that it duplicated almost exactly the events of the Miami hurricane just two years before. Man's action contributed a larger number of sensational happenings, most startlingly so in the field of dams. A great gravity dam failed, because carelessly built on an unsound foundation; two earth dams came to the very edge of disastrous failure by washing out; a newly built earth dam slumped because the soil under it squeezed out.

Decidedly different in nature, yet hardly less sensational, was the forceful decision of the federal Supreme Court outlawing the water diversion from the Great Lakes to the Mississippi through the canal of the Chicago Sanitary District for sewage-flushing uses—a decision that upset a course of 40 years development and was reached only after nearly two decades of litigation. Other developments that are of outstanding significance are the growth of problems of city street congestion and the development of a wider recognition of the importance of city and regional problems.

Mississippi Flood Control

WORK in providing flood protection for the alluvial section of the Mississippi Valley has settled down to the early part of a long construction program. In the first months of 1928 the question of plan of procedure, both engineering and administrative, was under bitter discussion. There were important technical differences between a plan drawn by the Mississippi River Commission and a revision of it prepared by officers working directly under the Chief of Engineers of the army, but far greater was the difference in cost estimates, the one exceeding $600,000,000 while the other was less than $300,000,000. The latter accorded with the President's desire to hold down costs. It assumed among other things that practically no land damages would have to be paid. Coupled with it was the recommendation that autonomous conduct of work on the Mississippi be abandoned and the work placed under direction of the

An Editorial Survey

Chief of Engineers. The Chief of Engineers plan with this provision, but also with a provision specifying payment for land taken or damaged, was adopted by Congress as an administration measure; at the same time, however, a review of the two plans was ordered, to be made by a board comprising representatives of the two plans and an independent civilian. But in the appointment of this board the spokesman of the rival plan (the late Col. Charles L. Potter) was displaced, and the board brought in a blanket indorsement of the Chief of Engineers plan.

The act of Congress of May 15, 1928, which embodied this plan of flood control with slight modification, appropriated $325,000,000 for engineering and construction. An allotment of $24,000,000 of this sum was made for the fiscal year July 1, 1928, to June 30, 1929, and commitments for the total amount have been made. In December the Bureau of the Budget entered an item for an expenditure of $30,000,000 for the year ending June 30, 1930, and this item was made a part of the appropriations bill now before Congress. Engineering and construction activities have been prompt. Surveys and gagings have progressed far, the study of floodway hazards and the appraisal of damages have gone ahead, levee construction amounting to some $9,000,000 and about the same value of revetment, contraction structures and channel maintenance work has been undertaken, the engineering plans of the Bonnet Carré spillway were well advanced, and the government construction plant and servicing equipment were substantially increased and improved. The engineering direction of the flood-control work has been completely reorganized. Altogether the set-up for actual construction is well advanced by the activities of 1928 and considering the time restrictions a notable amount of construction has been undertaken.

Flood Problems and the Everglades

IN VIEW of the wide spread of flood problems, it is of value to note two recent developments of contrasting character, involving the Vermont flood situation and the Florida Everglades. In Vermont a board of engineers advised the state that an extensive system of storage reservoirs built by joint action of the state and private power interests could serve both to control floods (like the great flood of 1927) and to produce water power. In Florida, where the September hurricanes of 1926 and 1928 caused great floods by forcing the waters of Lake Okeechobee far above the low levees along the east rim, a demand has arisen for federal aid in preventing the recurrence of such floods. The matter is now before Congress. State and local interests have heretofore spent twelve to fifteen millions in diking the lake and providing outlet and drainage canals, but now claim that they are unable to go ahead unless they receive federal aid.

Boulder Dam

ENGINEERING study proved a strong factor in settling for the present the long-fought matter of Colorado River development by a great storage reservoir at Black Canyon—the famous Boulder dam project. Last spring, despite long discussion and active parliamentary work, Congress failed to act on the project, but soon after resuming its session in December the bill was passed, closely in the form in which it has been up for several years. This action followed the presentation of a notable report by an engineering board appointed to pass on the feasibility of the project partly because the collapse of the St. Francis dam in March had created doubt as to the possibility of building a safe dam more than 500 ft. high. Among the matters which the board decided are that it is feasible to build the dam and to make it a safe structure; that Black Canyon is a better and cheaper location than Boulder Canyon; that the projected 26 million acre-foot storage would effectively serve the joint purposes of flood prevention, river regulation and power and irrigation service; that under specified conditions the project would probably repay its cost; and that the All-American canal can be built and maintained successfully. These findings resulted in prompt approving action by Congress. The bill as passed requires as condition precedent that the seven states of the river basin ratify the Colorado River compact, or that, after six months, six of the seven ratify. It also requires that repayment be assured before work is begun. One important incident of its passage was that an amendment offered in the interests of Arizona, virtually recognizing that state's claim to receiving power royalties, was rejected by a heavy majority.

Power Generation

POWER generation, both steam and hydro-electric, is continuing its rapid development, steam power remaining well in the lead because of its advantages in most locations for supplying rapidly increasing power demands. How great these demands are is shown by an article by George A. Orrok published elsewhere in this issue.

Increase in the size of power units continues to be the rule; the turbine runners of the new Conowingo hydro-electric plant are the largest in physical dimensions yet built, although not of so great capacity as the larger of the turbines at Niagara. In steam stations the 160,000-kw. unit in the Hell Gate station in New York is the largest erected up to date and is noteworthy also because of its great output per square foot of area occupied.

Two developments in the hydro-electric field of more than ordinary interest are the recent adoption of movable blades for turbine runners in the Chippewa Falls plant in Wisconsin and the construction of a pumped-storage plant on the Rocky River in Connecticut. Both schemes have been used in Europe, but are new in this country.

Power on the Coast

WATER power always has been and now is the principal source of energy on the Pacific slope. With 70 per cent of the undeveloped water power of the United States located west of the Rockies, it is natural that increasing power demands in the decade since the World War should have brought about unprecedented hydro-electric development. The situation is now changing, however. In the last year or two the steam turbine has gained very rapidly in relative importance as a prime mover, and a still further drift in this direction is indicated for the future. Existing power development, of course, is preponderantly hydro (in the West, about two-thirds of the total installed horsepower). Heretofore most of the steam plants in territory where water power is readily available were built for stand-by service

An Editorial Survey

on hydro-electric systems, but now steam-generating stations are being built as major additions to a power system.

Although the situation involves many factors, there are three principal reasons for the drift to steam power—namely, (1) marked increases in the efficiency of large steam boilers and steam turbines (an average operating efficiency in the larger plants today being about 475 kw.-hr. per barrel of oil), (2) low fuel costs (large consumers now buy fuel oil as low as 65 cents per barrel in the vicinity of oil fields and natural gas prices are correspondingly low) and (3) hydro-electric development costs have been steadily increasing.

Power at Niagara Falls

A PROTOCOL between the United States and Great Britain was signed during the latter part of the year looking toward the preservation of Niagara Falls and the enhancement of its beauty as a spectacle, also permitting the diversion of additional water for power purposes during certain seasons of the year. It provides for the construction of submerged weirs above the falls and for some dredging to divert water from the center of the stream to the flank of the falls. A daily water diversion at the rate of 10,000 sec.-ft. in addition to that now diverted on both sides of the river is authorized between Oct. 1 of any year and March 31 of the following year of the seven years during which the convention is to stand. It is expected that part of the work will be carried out this year and the remainder in 1930.

Experiences With Dams

THE St. Francis dam failure did more than cause widespread destruction of life and property in the valley below; it started the machinery for new laws on dam supervision, aroused the public to a state of apprehension about the safety of all dams and gave to engineers and laymen alike an impressive object lesson in the potential danger in stored water. Progress has been made toward a new California law on dam supervision, in the drafting of which engineers and engineering societies took a leading part.

Confidence in dams has been shaken not only by the St. Francis disaster but also by later accidents to other dams. Earth dams at Greenville, S. C., and Pleasant Valley, Utah, suffered partial washout. The nearly completed Lafayette dam in California, a rolled-fill embankment, was wrecked by a flow of the clay foundation. The Lake Pleasant multiple-arch dam in Arizona developed alarming cracks. As a result the security of existing dams far and wide has been checked up, and money is being spent more freely than in the past to provide ample safety factors and stability. The present situation, therefore, is a decidedly healthy condition and it is probable that never before was the public interest so carefully safeguarded as at the present time.

The past year has also seen progress toward greater refinement in the design of dams with a view to making it safe to work concrete at higher stresses and hence to build safe structures of new types whose unit costs will be lower than is possible in the older types. In addition to research carried on under the direction of Engineering Foundation in analyzing and studying the stresses in arch dams, numerous independent investigators have planned or built dams that depart from standard design. A notably successful instance is the recently completed Coolidge multiple-dome dam on the Gila River in Arizona.

Bridge Construction

STRUCTURES of nearly every major type—arch, suspension, cantilever and continuous, as well as the more prosaic but nevertheless important concrete trestle-bent viaduct—are represented in the active work of constructing large river crossings, which continues even more energetically than in the half-dozen years past. By far the larger part of the activity is in highway bridges; the major railway items are progress on the Chesapeake & Ohio Railway Company's bridge at Cincinnati, and War Department approval of the Southern Pacific's plan to replace its Suisun Bay ferry by a bridge.

Following soon after the initiation of work on the 3,500-ft. Fort Lee suspension bridge over the Hudson River, the Port of New York Authority last year completed its studies and let contracts for a 1,675-ft. steel arch bridge over the Kill van Kull, some 15 miles to the south. Utilization of alloy steels in an amount exceeding 50 per cent of the total tonnage of the structure and of steel forgings in the hinges are important characteristics. The close rival of this structure, the Sydney harbor bridge in Australia (span, 1,650 ft.) continues in construction. A 600-ft. steel arch highway bridge over the Colorado River 6 miles below Lee's Ferry and 130 miles from a railroad was completed last fall. Two large cantilever bridges of importance were completed during the year, crossing Arthur Kill between New York and New Jersey. The Montreal South Shore bridge is progressing according to schedule and will be finished within twelve months. A 1,050-ft. cantilever crossing bridge at Charleston, S. C., is under construction.

Work on the Detroit River suspension bridge with its span of 1,850 ft., and on the Mount Hope bridge near Providence, with a suspension span of 1,200 ft., is nearing completion. The tipped east main-pier caisson of the 1,500-ft. mid-Hudson suspension bridge at Poughkeepsie has been righted, so that work on this long-delayed project should continue rapidly. Three new suspension structures of more moderate span, about 700 ft., have been completed over the Ohio River at Steubenville, Ohio, and Point Pleasant and St. Marys, W. Va., the latter two being eyebar cable bridges. New truss bridges over the Mississippi River are located at Cairo, St. Louis (Chain of Rocks), Vicksburg, Quincy, Ill., Memphis and Cape Girardeau, Mo., and Ohio River crossings are under way at Paducah and Louisville. Continuous truss structures received recognition in the completion of a 500-ft. continuous truss across the Missouri River at St. Joseph, Mo., and the design of a continuous structure across Lake Champlain.

Several major projects in long concrete trestle bent construction were recorded, principal among which were the 5-mile James River bridge and the 7-mile San Mateo bridge across San Francisco Bay.

Building Progress

TALL buildings continue to grow taller and large buildings larger. In New York City the 56-story Chanin Building, 626 ft. high, has been opened; work is under way on the 68-story, 808-ft. Chrysler Building, and

plans have been announced for a 50-story building on the site of the Waldorf-Astoria Hotel which will be 650 ft. high and contain 2,000,000 sq.ft. of floor space. In Detroit the new 47-story Penobscot Building, 666½ ft. high, tops all other structures. In Boston a new legislative act permits setback buildings to be built higher than the prior maximum of 155 ft., thus permitting plans to continue for the 28-story New England Building, more than twice as high as any building in the city with the exception of the Custom House tower. In Kansas City fourteen stories were added to the existing 14-story administration building of the Southwestern Bell Telephone Company, making it the tallest structure in the city, while in Minneapolis the Foshay Tower, rising 32 stories to a total height of 450 ft., will dominate the skyline. Outstanding in the list of large structures is the proposed Merchandise Mart, in Chicago, which will contain 53,000,000 cu.ft., being more than twice as large as the next largest structure, the Equitable office building in New York. In Philadelphia the Fidelity-Philadelphia Trust Building, 30 stories or 377 ft. high, takes rank as the largest building in the city, with a volume of 11,500,000 cu.ft.

Increased interest in wind stresses brings into relief the unsatisfactory condition of present practices with regard to wind forces and methods of analysis. Studies being made on the American Insurance Union Building in Columbus, Ohio, where strain-gage points were placed during erection, should produce valuable information.

So far as innovations in structures are concerned, they have been few. There is a discernible increase in the use of open-web floor joists in tall buildings, a notable example occurring in the 42-story Grant Building in Pittsburgh. There is also a growing tendency to include several stories of garage space in the basements of new office buildings; also multiple-story garages in various designs are under construction in all cities where street parking is a problem.

A 21-story 235-ft. apartment building completed in Chicago ranks as the tallest reinforced-concrete structure built during the year. An unusual departure from previous practice was recorded in Philadelphia, where cinder concrete masonry units were used in two 25-story buildings for fireproofing.

Structural welding by the electric-arc process advances steadily. During 1928 a large factory structure at Philadelphia provided important data on shop fabrication of roof trusses by welding. In a warehouse built at Chicago, 80-ft. roof trusses were welded and built-up column sections were welded by automatic machine. Other important structures include a twelve-story hotel at Hot Springs, Va., a power house at Atlantic City and buildings at Tonawanda, N. Y., and Cleveland, Ohio. The major structural welding operations involved some 3,000 tons.

Sewage and Refuse Disposal

DECISION by New York to enter on much enlarged programs of sewage and garbage and refuse disposal is significant both in itself and because action by New York is bound to influence that of other cities, although a wise choice of method for treating either class of wastes will always be governed by a careful study of local conditions.

By taking steps to add materially to an already large number of garbage and refuse incinerators, New York City has committed itself definitely to that means of disposal of mixed refuse. This is in line with conclusions reached some years ago by an investigating committee. It is also in line with the recent trend of American practice in building new waste-disposal plants. Reduction plants (treating garbage only) have not quite held their own of late. Hog feeding has had brilliant results at Los Angeles, but notable additional hog-feeding plants have not been reported. Incineration, therefore, seems now to be decidedly in the lead.

In the case of sewage treatment, adoption of the activated-sludge process for a million or so of the population of New York City will give new courage to the engineers who have persistently advised that process since it came to the front a dozen years ago. Even with a part of New York, a part of the Chicago Sanitary District, all of Milwaukee, Indianapolis, Houston and some lesser cities, there are as yet only a few score activated-sludge plants in the United States and Canada. Conversion of the sludge into a commercial fertilizer has yet been attempted at only three or four plants. How well their difficulties have been overcome it is too early to say, and there are yet no complete cost figures. The sludge from the huge plant put in use at Chicago last year is not being made into fertilizer, and only a relatively small working-scale sludge-recovery plant has been authorized as a part of the Ward's Island project, New York City. Separate digestion both for excess sludge from the activated-sludge process and from Imhoff tanks is on the gain, as also are variously mechanically operated accessories to sewage treatment. On the whole, the promise for the future of both garbage and sewage disposal, as to number of installations and improvement in the arts, is promising. Overshadowing clouds as to the successful operation of plants built at large outlay continue because of the failure of municipal governing bodies to take these works and their personnel out of politics and into engineering.

Drainage Canal Decision

NAVIGATION shall not be injured in favor of sewage disposal; the arts of sewage and water treatment have reached such a stage that menace to health because of their inadequacy or unreliability can no longer be urged as a reason for permitting an injury to navigation; the federal government is still supreme over states and cities in matters affecting navigable waters—these are some points implied in the decision of the United States Supreme Court on Jan. 14, upholding the contention that the Chicago Sanitary District is unlawfully diverting water from Lake Michigan to the detriment of navigation on the lakes. Grant of time before the issuance of an order to put the decision into effect is given to meet conditions brought about by the action of the sanitary district in continuing diversion beyond the rate allowed by the temporary permit of the Secretary of War and by the laxity of the lower federal courts in handling the government's suit against excess diversion. The only hope for Chicago and its neighbors to be saved from treating the sewage of three million people to a far higher degree than is practiced by any of the largest cities of the world as regards their entire output of sewage lies in the possible construction of lake-level regulating works, as already proposed, or the possibility, more

An Editorial Survey

An Editorial Survey

remote and uncertain, that Congress will grant, and the Supreme Court uphold if granted, the right to divert water from Lake Michigan to provide navigation in the proposed Lakes-to-Gulf Waterway.

Water-Works

PROGRESS continues in extending existing water-works and in constructing plants for the villages and hamlets still without a public water supply. Innovations in design and construction are few and minor; steel and reinforced concrete for large water pipe are gaining in use, with jointing refinements for steel pipe to lessen friction. Municipal ownership in the few large cities still supplied by private water companies has had notable additions, either effected or in progress during the year. San Francisco a few months ago voted to buy the distribution system of the Spring Valley Water Company, and across the bay Oakland and other communities took over the distributing plant of the East Bay Water Company. In both cases large new gravity sources of water supply are being developed at public expense. Municipal acquisition of the works of the Passaic Consolidated Water Company in New Jersey by a group of cities is under way. With these purchases completed, there will be only five (of 68) cities with a population above 100,000 dependent upon private water companies. In ownership the trend is clearly municipal for works large and small. Where private ownership continues, holding companies are taking over the isolated private companies and in some cases are consolidating operation in adjacent territory, as from Scranton to Wilkes-Barre.

Railways

RAILWAYS have for several years been reasonably prosperous. Only a few of them, however, are earning an income comparable with that of industrial organizations, which gives the railways no reserve for a period of depression. Moreover, two important matters remain unsettled: the basis upon which valuation is to be established and the future of consolidation plans. The test case in the valuation proceedings is now before the Supreme Court. All definite consolidation plans await Congressional action on bills proposing to modify those sections of the transportation act which now effectively check any real consolidation of several railroads into a unified system.

Most noteworthy among the developments in railroad expansion during the year was the large amount of electrification work definitely determined upon. Early in the year the Lackawanna announced that it would undertake at once the electrification of its suburban lines at New York. Subsequently the Pennsylvania announced its plan for the electrification of most of its main lines on the Atlantic seaboard, a program which is to be carried out over a period of years beginning with the expansion of electrification work now in progress around Philadelphia. Shortly thereafter the New York Central made known that it was studying further electrification of its Hudson River division. Electrification of the 15-mile Boston, Revere Beach & Lynn Railway and of the 75-mile division of the Great Northern which includes the new Cascade tunnel was completed during the year. The Reading has announced plans for electrification of its Philadelphia suburban system.

Passenger terminal developments were unusually active during the past year and will continue to be so through 1929. The North Station at Boston was completely rebuilt during the year—a remarkably fast piece of work considering that the station had to be kept in operation while the work of reconstruction went on. The New York Central's new Buffalo terminal will be in operation soon, and Cleveland's new union terminal is well along toward completion. Much work was done during the year on the new Pennsylvania terminal at Philadelphia. Plans are in preparation for a new union station at Cincinnati. No progress is being made on the terminal station plans at Chicago. Construction of new railway lines was also active, an unusual amount of new line having been put into service and much work done on double tracking, line improvements and relocation. This activity will continue during 1929. In Canada, where railway construction has been at a low ebb since the war, much new construction in the prairie provinces is in prospect.

Waterways

EXCEPT for the extension of the Mississippi River Barge Line service to Minneapolis and St. Paul no material changes are in progress in the waterways system of the country, but two important developments are in early prospect: completion of the slack-water navigation channel in the Ohio River and the opening of the new Welland Canal. Already the Canadian government is beginning to make provision at Prescott, Ont., for the extension of deep-draft lake navigation to the headwaters of the St. Lawrence River. So far little has been done on this side of the line toward taking advantage of this enlargement of the Welland Canal other than a study by a firm of engineers on the possibilities of Oswego as a port for deep-draft vessels. Prospect for enlargement of the St. Lawrence waterway still is remote. Some progress was made on the intracoastal waterway along the Atlantic seaboard, and during 1928 the federal government took over the Cape Cod Canal as part of that waterway. Construction work proceeded on some of the locks and dams of the Illinois waterway, to connect the Chicago River with the Illinois River and thus the Great Lakes with the Mississippi, but the time of completion of the project is in doubt.

Rapid Transit

LITTLE progress toward actual construction is apparent in the several large cities of the country where rapid transit has been under consideration. In those which have expansion of rapid transit actually under way there is excellent progress. At Philadelphia, where an additional subway has been under construction for nearly four years, the Broad St. section north of the City Hall was put into service in September under a temporary operating agreement pending a decision on permanent operation. At New York, work on the city's new Eighth Ave. subway with its outward extensions is going ahead actively. The system is to be municipally operated and there is a possibility that the city may take over all or part of the existing privately operated subways and operate them with the new subway as a unified system.

Detroit, which has had rapid transit under consideration for a number of years, will soon vote on a pro-

posal to build a rapid-transit system of about 15-mile length consisting in part of subway and in part of elevated structure.

Highway Trends

CURRENT highway progress is marked by keen interest in the improvement of roads as tools of transportation. This was manifested during 1928 chiefly in the planning and perfecting of road service for metropolitan areas, but the conception is extending into rural road planning. Reduction of constrictions, increase of sight distances, greater ridability, better marking and signaling, and ways of conveniencing travel are all engaging thought. In expenditures for highways the year probably will show a total of some $1,300,000,000, or about $100,000,000 more than in 1927, but newly surfaced mileage probably does not exceed the 53,432 miles of 1927. The increased expenditure is going into maintenance. This is a hint of a future trend.

In pavement design, subgrade studies and construction procedure there has been continuation of the lines of progress noted in recent previous years. Construction has advanced most, and unit output is twice that of two or three years ago. Expenditure for low-type roads to serve wider rural territories has kept at a high figure and shows no indication of waning. Indeed there is no indication of cessation anywhere in the provision of money for highways. Iowa, West Virginia, North Carolina and Louisiana all authorized road bond issues in 1928; that of Iowa, $100,000,000, was the greatest ever voted at one time by any state for road construction. The country over there is no present lack of reasonable provision of money for road improvement, but probably also no state or county road department has all the money that it sees means of spending profitably. There is looming a big problem in highway financing. A minor trouble, but one that has grown during the year, is the privately financed toll bridge. Both the Bureau of Public Roads and most state highway departments vigorously oppose these structures on the public roads; yet state and national legislators go merrily ahead granting charters.

Traffic Control

MORE and more engineering is being brought to bear on traffic control. The traffic problem is being attacked on the one hand by operative methods and on the other by fundamental or constructional methods. Lack of harmony still exists between those who want to control traffic for safety's sake only and those who seek to expedite traffic. It is being recognized that some controls increase safety, others reduce it.

The safety factor is receiving much consideration. To determine why accidents are increasing in some places and decreasing in others has been found to require more than casual analysis. Strong claims are made for the helpful effect of requiring drivers to be licensed, but observation in some states that have no such laws throws doubt on these claims.

As to details, the no-parking plan of expediting city street traffic is gaining ground. Chicago, after a year's trial, would not go back to the old system which congested its loop district. New York in this country and Berlin abroad have just inaugurated no-parking. Many smaller cities such as Denver still cling to the principle of "making a stable out of the King's highway." Off-the-street parking proposals are being studied more seriously than ever.

Marking of traffic lanes on pavements is progressing rapidly, and street efficiency is raised thereby. The traffic carried by the Holland tunnel between New York and New Jersey in four lanes has this year furnished a notable illustration of the efficiency of lane marking. Pedestrian control also is making progress, though slowly.

One of the heartening things of the year has been the promulgation of a model traffic ordinance and a manual of uniform traffic signs, signals and markings. Country-wide adoption of these meritorious endeavors will lighten the burden on the motorist in a strange town. All things considered, the drive toward better efficiency in street use is about keeping pace with increasing congestion due to "new business" from added car registrations. Few cities are now using even 50 per cent of their possible street capacity and as further efficiency is required the urge for relief by construction—grade separation, double-deck streets, widening, new streets and above all smooth pavements—will become more and more insistent.

Regional Engineering

CONSCIOUSNESS of the comprehensiveness of engineering problems in metropolitan areas has grown rapidly in recent months. More money than ever is being spent for comprehensive surveys disregarding political boundaries. Both official and volunteer attacks on the regional problem show development. Los Angeles and Milwaukee counties, which have official regional planning departments, are about to be joined by Allegheny County—Pittsburgh and vicinity. The Chicago type of organization, effective through co-operation among existing political units, individuals, corporations and utilities, is about to be emulated in the Kansas City region, which will embrace six counties in Missouri and Kansas. The Regional Planning Federation of the Philadelphia Tri-State District during the year concluded a drive for more than half a million dollars and is now organized with a board of leading citizens, including two prominent engineers to direct engineering studies. Certain elements of a plan, such as bypass highways, parks and public reservations, have already been worked out. Los Angeles and Milwaukee counties have adopted county zoning for use; they also have a workable means of obtaining wider rights-of-way in their controlled platting procedure. The comprehensive survey of the road situation and needs in the region of Cleveland, with prearranged agreement by 62 separate municipalities and townships in six counties to accept the plan for a ten-year program, is a piece of work even more significant than that so well done in the Chicago region in 1927.

Air Transport

THE remarkable progress of air transportation during the year is emphasized elsewhere in this issue. It is expressed also in the statistical figures: On Jan. 15 there were 19,254 miles of airways operating, over which there was a daily schedule of 40,061 miles. There were 9,341 miles of airways equipped, under construction

An Editorial Survey

or contracted for night flying, with 1,479 electric or acetylene beacons, 259 lighted intermediate fields and 29 radio weather reporting and communication stations. The Weather Bureau maintains 46 upper-air meteorological stations. Eight cities have mooring masts. Three broadcasting stations for radio-telephone communication with aircraft are in operation and apparatus has been ordered for fifteen additional stations. The directive radio-beacon service is now complete between New York City and North Platte, Neb. In 1927 the average load per scheduled trip was 133 lb.; in 1928 this had been increased to 319 lb.

Although this country has 425 municipal airports with an additional 942 under construction or proposed, the American Air Transport Association believes that progress will be even greater in 1929 because of a recent decision by the Supreme Court of Missouri upholding as legal municipal appropriations for airports. In addition to the municipal airports, there are 450 private and commercial airports, 63 army and 17 navy fields.

With 200 airplanes in service by airway operators and more than 7,800 civil airplanes in use in miscellaneous flying, it is evident that more flying is being done away from established airways than on them. Thus the recent decision of the Federal Board of Surveys and Maps to replace the existing strip maps with sectional area air maps on the international millionth scale is unusually important.

Construction Methods Advancing

CONSTRUCTION operations are undergoing a rapid change, not through radical differences in procedure but rather through increased efficiency, speed and performance. Three projects of last year can be pointed out as examples: the new Cascade tunnel, an 8-mile bore completed in three years; the James River bridge, 5 miles of concrete pile and steel beam trestle built in thirteen months, and the New Jersey tower foundations of the Hudson River bridge, two large open cofferdams carried to the unprecedented depth of 79 ft. below water. No new construction principles were introduced on any of these three projects. Modern equipment, careful planning and organization made possible what not so long ago would have been thought impossible.

Projects of unprecedented magnitude are under construction today. The Hudson River suspension bridge with its 3,500-ft. span will be twice as long as any previous similar structure. Saluda dam in South Carolina will contain more than 11,000,000 cu.yd. of fill. Cobble Mountain dam near Springfield, Mass., a hydraulic fill, will rise to a record height of 245 ft. These are structures larger than we have ever known. Work of this magnitude, even though it does not call for radically new methods, requires an organization of increased technical skill and knowledge, improved equipment, better plant layouts and carefully planned schedules to permit more thorough co-ordination of various steps at the desired speed. The construction industry as a whole is adjusting itself to the new magnitudes and the new speeds set by modern engineering undertakings and modern understanding of the cost of leisure in finishing work begun. In road construction the season's output has been doubled in the last few years. Building construction, too, has reached a speed never before realized as possible.

Concrete

THE concrete art was not affected by any unsettling developments. Water control and comparatively dry mixes have been generally accepted as necessary to produce good concrete, but the use of strength specifications is still infrequent. On the other hand, the question of increased design strength for concrete has assumed importance on the several building code revision programs under way. There is a healthy questioning of some factors in concrete manufacture. What is the measure of workability; have we accomplished the ultimate in aggregate control and grading; how can density be secured—such questions are receiving much attention.

The central mixing plant has enjoyed extended use during the year, as has the production of precast units for bridges, docks and reservoirs. Advocates of both continue to stress the salutary effect on concrete of the careful control which centralized manufacturing conditions afford. On the other hand, the central mixing plant, or more correctly, the central batching plant, has fostered the development of truck mixers, the use of which places the time of mixing and the water-charging functions in the hands of a truck driver. This apparent tendency to retrogress in matters of careful mixing control is viewed with concern in some quarters.

Materials of Construction

IN THE field of materials some important developments are being recorded. Alloy steels are used in increasing quantity in several large bridges. A new method of heat treatment for cable wire was introduced during the past year, and, judged by the use of the wire on several bridges, it has proved itself commercially advantageous; the treatment does not appreciably improve the ultimate strength, but it raises the yield point of the wire by a third. As a result of an unusual program of testing work incident to cable construction for the Fort Lee bridge, there was constructed a testing machine with a capacity of 2,000,000 lb. The year saw the successful rolling of 36-in. girder sections and an increased use of rolled sections for columns in buildings.

Cement manufacture gave indication of entering a new stage in its development. In 1927 there was noted a tendency toward the establishment of one or more special grades of cement with higher properties than portland. During 1928 this trend was maintained, though not as strongly as expected. It is too early to evaluate the effect of these changes, but cement manufacture is evidently emerging from the era of the single standard and approaching a situation in which each cement will be sold on the private claims of its manufacturer. The 1928 consumption of cement showed but slight gain over 1927, and there is still an excess of production capacity.

Equipment Advance

IMPROVEMENT in construction equipment is turning from invention to engineering. There are relatively few construction operations for which there are not machines. New tools are therefore appearing less frequently, while old tools are becoming more simple, durable, useful and efficient. With the shift of equipment designing from the inventor to the engineer the

An Editorial Survey

requirement for research and analysis is emphasized. Recognition of this fact is exemplified mainly by the strengthening of manufacturers' technical staffs, but special research has not been lacking. Thus a scholarly and costly research into the actions inside a concrete mixer which influence the quality of concrete has recently been made by one manufacturer. Another has by a closely checked campaign of field testing on actual work made a determination of the requirements of a finishing machine for asphalt pavements. So, by surveys of experience analyzed by trained engineering staffs, manufacturers widely are improving equipment design. Competent technical staffs are the creative factors in this development. They have interpreted the research results and have transmuted them into equipment improvements. Not the least part of their service has been in applying the advances in other machinery fields, as automotive engineering, to construction equipment. Throughout, the influence of skilled engineering in equipment improvement is the outstanding feature of the year just gone. It may be expected to increase. A secondary feature is represented by important mergers of equipment makers. If these are utilized for increased service to the industry as well as for increased profits to the stockholders, great advance is possible, for the larger companies should command greater bank accounts and engage the best engineering skill.

Stabilizing Contracting

CONTRACTORS had a favorable year in 1928. There was a large construction program, weather conditions were good and there was a remarkable lack of trouble with labor. Yet the perennial complaint of low price levels showed no moderation, particularly in the public-works field. In roadbuilding, the evil of irresponsible competition, upheld by loose credit practices, easy surety bonding and the difficulty of evading the statutory compulsion to accept the lowest bid, has continued to act disruptively. An outcome of this has been increased activity of the contracting fraternity in seeking better practices by conferences with manufacturers and surety bonding companies, by urging prequalification of bidders and by setting its own house in order in all credit dealings.

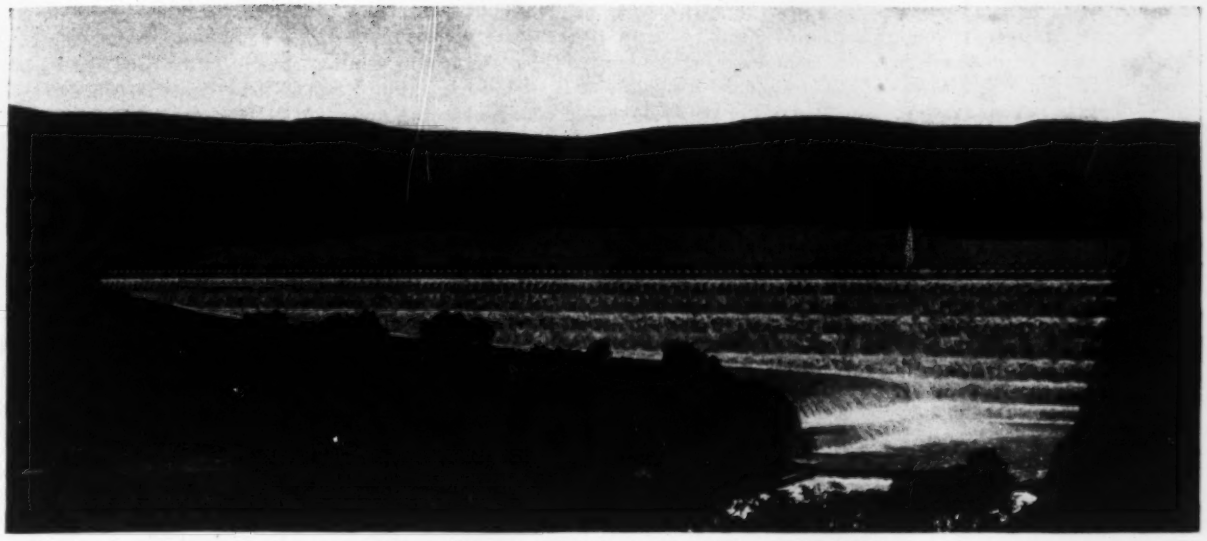
This constructive activity is slow in producing the desired effect, but there is progress. Makers and merchandisers of the things that contractors use are increasingly adopting the credit schedule proposed by the Associated General Contractors, which includes larger down-payments and shorter time-extensions than the business practice of recent years. Bureaus affiliated with A.G.C. chapters are beginning to be organized. These include equipment manufacturers and dealers, materials producers and bonding companies—all factors in construction. With its bylaws changed to permit affiliation and a staff representative revoting his time to organization and co-operation, organized contracting may hopefully contemplate progress in joining with all elements of the construction business to create a stabilized industry. Not the least of the services of these affiliated bodies will be the demand on contractors to set for themselves the high standards of dealing that they require of their co-workers. In the building field, a very close working partnership for stabilizing credit practices and other mutual affairs has been established between general contractors and subcontractors. Stabilizing the business has been accepted as a task which contracting has to perform by its own initiative. This activity will be the industry's chief task in 1929.

Construction Safety

THE safety movement in construction is progressing and despite a late start promises to equal the safety work carried on in other industries. Interest in safety in general is indicated by the attendance of some 6,000 at the National Safety Congress last October; the construction industry was represented by more than 300. No definite stand has been taken as a whole on the proposed national construction safety code. While mandatory legislation has unquestionable hazards, it has enough supporters to warrant the conclusion that a few years will see it well established. Meanwhile safety work within the industry is being carried on by committees of various contracting organizations and by individual contractors. A considerable number of constructors and groups of constructors now maintain their own safety organizations, and the practice is spreading rapidly. All this relates to the safety of workers. In safeguarding the public much remains to be done, particularly in building. Probably the most flagrant violation of safety principles is the continued practice of hoisting steel and other materials over crowded streets and walks. As to the related subject of the inconvenience caused the public by most building operations, many cities have ordinances regulating construction practices in regard to public welfare, but these are almost universally ignored. Unnecessary and careless street blocking is particularly common. Search for relief for the rapidly increasing congestion of city streets is drawing outside attention to these practices.

The Professional Outlook

CONDITIONS within the engineering profession indicate steady constructive progress. While there still is frequent occasion for dissatisfaction in matters of the compensation of employed engineers, fees of consulting engineers and bidding for engineering work, such troubles have not been numerous or serious within the past year. Interest in engineering registration is growing, and while no state was added to the registration list during 1928, the movement is in no way going backward. A careful review of the present situation has been included in this issue, its author being a man long prominently identified with its promotion. Another matter internal to the profession, namely, development of society work, is in an interesting condition, as society growth has reached such a point—the American Society of Civil Engineers now has 13,500 members and is growing by nearly a thousand yearly—that the effectiveness of the technical work may suffer from the effects of size and complication. Much thought is therefore being given to means of rendering adequate service to the entire group; the society is trying to expand the functioning of both its technical and its geographical elements and make them, so to say, components instead of subdivisions. It also recently decided to join American Engineering Council. For the latter organization this is a move of great importance, because it brings all the major engineering societies together in relation to public and professional questions.



A 1,324-Ft. Spillway on a Drainage Area of 314 Square Miles

Dam Construction and Design

Current Practice Viewed as the Expression of an Art Seeking the Enlightenment of Science—The Engineer as the Exponent of the Art

By THADDEUS MERRIMAN
Chief Engineer, Board of Water Supply, City of New York

EVENTS of the past year have brought the question of safety in dam construction prominently into the forefront of both technical discussion and public notice. The dread of disaster occasioned by the outrush of impounded water is one of the instincts of humankind. It transcends the fear of fire and of lightning, both of which are of relatively frequent happening, while floods resulting from dam failures occur but seldom.

Dams are in a class apart from most of the structures which belong in the province of the engineer. Bridges, buildings, roads, canals, water pipes, sewers and other similar constructions are susceptible of close observation as to behavior and may be maintained and repaired as occasion requires or necessity demands. Not so with a dam. Once such a structure has been completed, only part of its surface may be observed. The foundation and the interior mass are hidden from view and may be neither inspected nor satisfactorily maintained or repaired. This aspect serves to indicate that the fundamentals on which the design of dams is based should, in their application, begin on a plane different from that which serves as the base for other types of construction.

This viewpoint is further emphasized by the consideration that a dam, together with the material that surrounds it, is constantly required, year in and year out, to withstand and to resist not alone the forces which come upon it but also the solvent, the softening and the disintegrating effects of the impounded water, together with the changes in shape and form induced by temperature variations. The effects of time thus constitute a more important factor in the design of dams than in any other field of engineering. The forces and influences acting within the environment of a dam are such that its safety, as the flood of the years rolls on, may be reduced to the vanishing point. The strength and security of a dam must be viewed in terms of its useful life. Factors of safety which obtain when a dam is new are not an *a priori* measure of future stability.

The Controlling Demand of Safety

Most dams have served their purpose well, but the fact that there have been failures, both actual and incipient, should lead the profession to a frank analysis and introspective study of the merits of the technical and other considerations that are involved. An inquiry of this nature, in all fairness, must be predicated fully as squarely on the viewpoint of those who live below an impounding dam as on any theory of economy in construction cost. No upper owner, because of a saving in the first cost of his structure, may ever claim the right to cloud the title of any lower owner.

Present Trends and Attitude

The coming years will see more dam construction as well as higher and larger structures than the past has produced. The principles on which their design will come to be based will undoubtedly differ from those which have heretofore been followed. In the case of earth dams, there is already a definite trend toward larger and more stable cross-sections; gradually the slopes are being flattened. The old-time angle of one on two is no longer considered adequate. On the other hand, in the case of concrete dams it is being argued that, because it is possible to make a concrete which at 28 days will show a greater test-cylinder strength, there-

fore the working stresses may be safely increased—in other words, that the cross-section of a dam built of such concrete may, in the interest of economy, be made smaller. In the future we shall undoubtedly evaluate more definitely the relationship between the 28-day strength of a concrete test cylinder and the strength of the same concrete in a dam at some later time in its life.

Tests and Their Meaning

Force of habit and close association with test cylinders, with laboratory practice and with published test results are apt to produce conclusions which may fail to do full justice to the subject of the strength of concrete. In the testing machine the specimen is subjected to a straight compression loading, and no external shearing force is applied. Yet in the body of a dam the same concrete must simultaneously resist forces of both types. Why should the compressive test alone be adjudged the true index of the strength of the material? And what is the merit of the 28-day strength as a basic criterion of the quality of a concrete?

Let us take eight pieces of wood and glue them together in pairs to make four identical test specimens. Two of the specimens are joined with high-grade hoof glue; the others with a casein glue. A physical test on one specimen of each pair now indicates that the two glues are equal in strength; but if the other two specimens are then exposed for a few days in a moist location, it is found that the hoof glue has lost a large part of its strength, whereas the casein glue has retained nearly all of its original quality. So also, though of course in minor degree, do the hydration products of the cement which constitute the binder in concrete differ in quality.

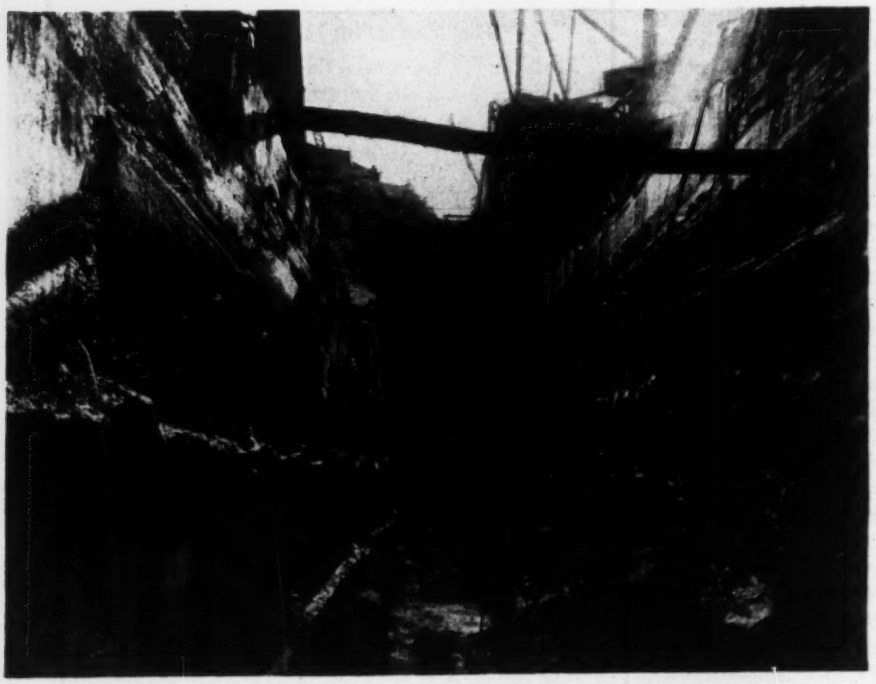
Such differences are not disclosed by the 28-day compression strength. Neither does the strength at this early age serve as an infallible index of the eventual strength of the concrete. The characteristics of the hydration products of different cements are such that concrete made with one kind will become greatly stronger after 28 days, another will show no increase and still another may retrogress. And when consideration is given to the resistance to solution shown by the different varieties of the hydration products it becomes possible to understand why the concrete in one structure begins to disintegrate at an early age while in another it stands firm and stable.

Future practice in the design of concrete dams will concern itself fully as much with the characteristics of the hydration products which serve to bind the structure together as it now does with analytical studies of forces and the stresses they induce. The engineer will stop considering cement merely as a dry powder delivered in 94-lb. bags and conforming to an arbitrary minimum specification. He will come to think in terms of its products, which alone make his concrete possible. His interest will be concentrated on securing from the cement the utmost which it holds in quality and durability of its hydration products. He will specify that cement which will produce a maximum of hydration products of the quality which his work requires. Technical thought will also more fully recognize that these hydration products are relatively soluble in water and that their solubility increases as the temperature is lowered. These considerations, on the one hand, will emphasize the importance of denser concrete and, on the other, lead toward ways and means for preventing the entrance of water into its mass.

Conditions in a Concrete Dam

The clinical picture presented by the body of a large concrete dam is of interest and importance. It is made up of sections of many shapes and sizes, cast on different days, at different seasons, and of cement of differing inherent characteristics. The technique of the placing of the concrete is also a variable. Some of it is wetter than that in other parts, and the bottom of each section is more compressed than is its top. As the cement sets, heat is generated and the temperature of the concrete rises. Some sections are thin and near the outer faces; in them the temperature rise is less than in those which are more massive and from which the heat finds less ready escape. Other sections placed on one day are immediately followed and covered by more concrete and their temperature climbs correspondingly higher. And throughout the sections there are differences in the quantity of water available for the hydration of the cement as well as in the quantity of cement per cubic unit.

Each section sets and assumes its shape at a temperature which not only differs from that in the others but which differs within its own several parts. Generally the temperature rise is such that the maximum attained under a cover of several feet of concrete is from 35 to 45 deg. F. above the average atmospheric



DEEP FOUNDATIONS INSURE STABILITY AND WATERTIGHTNESS

temperature during the first three days following the placing of the concrete. The maximum temperature attained in any section may therefore be as low as 65 deg. F. or as high as 125 deg. F. Thereafter, as the mass cools, the temperature at its center after several years continues to drop until it approximates the mean annual temperature of its location. If the mean annual temperature be 50 deg., a temperature range of from 15 to 75 deg. is thus indicated. Toward the exterior of the mass, where the seasonal temperature changes are more marked, the range is even greater. These temperature ranges are those which occur with average portland cement in the latitude of New York. In the case of cements developing a high early strength even greater ranges may result, since the total heat energy evolved during the early period of the setting process is greater.

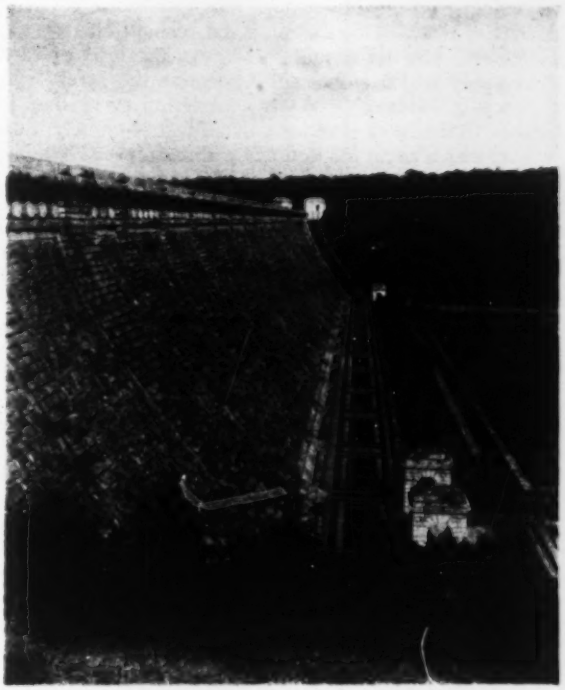
Temperature Stresses and Cracks

As each section cools down after placing, stresses are set up within its mass. These stresses act in all directions and may be supposed to be generally tensile with respect to any particle, but in many places they are undoubtedly additive to those induced by the external forces. A tensile deformation in one direction is equivalent to a compressive loading in a normal direction. The loading determined by the stress analysis may, in view of these conditions, not represent the true actual stress at any point within the cross-section any better than the strength of a test cylinder denotes either the actual strength of the concrete at that same point or its ability to resist the stresses induced by the external forces. These temperature stresses are applied gradually and do not attain their maximum values until the temperature of the interior has reached its minimum.

The temperature range which operates to induce stresses in concrete masonry is that from the highest temperature attained during the setting process down to the lowest subsequently reached. The wide range thus indicated results in cracks which are usually transverse to the axis of the dam and are quite generally provided for by expansion joints. Such cracks, while widest at the top, extend down through the entire cross-section and thus indicate the setting up of stresses at least sufficient to overcome the tensile resistance of the concrete.

In the case of very high dams, in which the base width approximates or exceeds 150 ft., longitudinal temperature cracks are to be expected and, as they occur, the analysis of the stresses requires substantial revision. The theory of the middle-third becomes difficult of application. Even in the absence of longitudinal cracks this theory takes no account of the manner in which the load distribution is influenced by the elastic deformations of the structure and of its foundations. The effect of these tensile forces in modifying the compressive stresses is a most important consideration, particularly when the resultant is translated into terms of the true maximum shear. Compression failure is impossible.

The foregoing factors are a few of those which have a bearing on the relationship between the computed stresses in a dam and the strength of the material composing it. Whether this relationship is denominated as the factor of safety or expressed as a safe loading in tons per square foot, the fact remains that in the present state of the art it must be fixed and determined as a matter of judgment. Whether a dam is safe and conservative under a loading of 20 tons, or 30 tons, or 40 tons per square foot depends upon the point of view.



A HIGH DAM IN COMPLETED FORM

It can hardly be gainsaid that a concrete dam designed on the lowest of these figures will remain safe for a longer time than one designed on the basis of the highest. The indicated measure of safety in the first case is usually about 7, while in the latter it is about 3½ on the basis of what is normally denominated as the ultimate strength. The actual safety in both cases, however, is undoubtedly less than appears on the face of the figures. How much less is the question that confronts the profession and presses for solution.

Broadly classified, all dams may be grouped into four general categories, as follows:

1. Masonry dams of sufficient volume to resist, by mass action, the loads and forces which come upon them.
2. Masonry dams designed to resist the external loadings partly by their own weight and partly by directional stresses within their several members.
3. Earthen dams or dikes with or without core walls.
4. Rockfill dams with impervious faces or diaphragms.

The problems presented under each of these classifications differ widely in both nature and detail. Yet with respect to each there are certain common underlying fundamentals.

The Human Factor

First and most important is the human factor. The builder of a dam must know his job.

He must be able to appreciate and understand the significance of the many details and evidences which the development of the foundation conditions brings to light. It is not enough to dig a hole and then fill that hole with concrete—even if the rock at the bottom has been grouted. The constructor must analyze every condition which bears on the geology of the site, both in its relations to the structure as well as to the surrounding territory.

No dam terminates along the contour of its own mass, and none within that compass is sufficient unto itself.

The geologist and the consultant may guide, and counsel, and advise, but the builder must be responsible for the final result. On his shoulders belongs the load of care and of study which alone will determine the safety and sufficiency of his work. After completion every dam is subjected to the most searching of all tests—namely, that of water, which as an inspector is without a peer. The influence of the water, moreover, is still more potent in the effects it may have on the strength and stability of all the surrounding materials. A dry rock does not necessarily show the same characteristics as after it has been wetted for a short time, and the continued action of water may induce changes of great magnitude.

Gravity and Other Dams

Within the limits of this brief review it is not possible to compass more than a mere fraction of the wide field of dam construction. Only a few general observations are possible.

The gravity dam stands alone in its class. Its mass symbolizes strength, permanence and endurance. It ranks high in public confidence, and when built on a curve for the purpose of securing a further obvious measure of stability it represents the highest expression of the art, as found in the practice of the day. The obvious, however, is not always susceptible of evaluation in the form of definite proof. A few of the factors affecting the problem of this type of dam have been adverted to. Space forbids reference to but one more—namely, the importance of a correct determination of the magnitude and intensity of the *true principal stresses* which are set up within its mass. The mute evidence on the downstream face of the St. Francis dam points to the existence of shearing forces of marked intensity acting in a direction not indicated by the usual forms of analysis. This evidence may eventually shed much light on this important consideration.

Arch and Buttressed Forms

The second class of dams includes those which depend for stability on arch and cantilever resistance; those of the multiple arch and buttress type, and those employing flat slabs. In this class the quality and impermeability of the concrete is a more important desideratum than in the massive gravity dam. While the determination of the principal stresses and their directions is somewhat more certain than in the monolithic dam, yet the foundation conditions are greatly emphasized and become of controlling importance. Still further, the assumptions of the design may not in all respects be precisely realized in the completed structure, and so liberal allowance for indeterminate factors and conditions must be made.

Earth Dams

Earthen dams are among the oldest of water-impounding structures. Their design is based on fundamentals very different from those applicable to masonry dams. Here again the dam proper is only a part of the mass which serves to restrain the water. The foundations and the adjoining hillsides are as much a part of a dam as is the portion which is placed under the supervision of its builder. There is no theory of earth dam construction. Current practice is founded on precedent and experience.

Recent tendency in the placing of earthen dams seems to be directed toward the method of pool sluicing, which has much to commend it. This method, however, is not adaptable to all classes of material, unless ways and means be developed for securing a more rapid compacting of the central mass of the finest material. For this shortcoming an adequate remedy will undoubtedly be developed, and thus a still greater degree of watertightness will be secured, although in certain classes of such material shrinkage effects on drying out may become of greater moment than they now are.

Like the earthen dam, the rockfill dam with an impervious facing is an indeterminate structure. It presents some features which are similar to those of the earthen structure, and others which resemble those of the skeleton type of concrete dam. The integrity and efficiency of such a construction are largely dependent on the watertightness of its facing, which is not as readily to be inspected as the sloping decks of its more rigid prototypes.

Safety Against Floods

Determination of spillway capacity is an essential feature in dam design. Influenced by numerous recent floods, the present tendency is toward larger and more generous provision for the discharge of excess water. In the absence of reliable data respecting maximum floods, formulas have been developed in the effort to predict both the maximum discharge and the probability of its occurrence. Available flood records cover a relatively short period. The designer cannot afford to be too greatly governed by the indications of these records. He must interpret the flow possibilities of each watershed from the topographic evidence of former floods.

The Danger of Speed

In these days of haste, the watchword is speed. Records on every hand are being broken and credit goes to him who moves the most material and places the largest volume of concrete within the shortest time. Speed in dam construction is desirable, but speed at the expense of complete design and proper execution is not conducive to the best result. As already pointed out, dams are not in the same category as other structures. Speed in the design and construction of a dam may lead to error or may abridge understanding of some vital and important feature which later may cause needless expense and alarm.

The Dam-Builder's Art

The successful completion of an enduring structure for the impounding of water requires more than the mere application of endeavor and industry. Not so elementary is the task. The dam builder must exercise both ingenuity and imagination. His vision must encompass the future. Beyond the horizon of the present and the obvious he must sense that perspective which alone will enable him to visualize the inwardness of his responsibility and lead him truly to its discharge. Questing thus for knowledge, the mediocrity of standardization will yield to him naught of either aid or comfort. Ever must the builder of dams dream the dream of greater understanding, and faithfully must he mirror its images in the completed product of his hand and mind.

Each year in passing adds its meed to the total of knowledge in the art of dam construction, but not until the uttermost shall have been revealed will that art become a science. Herein lie both the duty and the responsibility of the engineer. As the exponent of the art, he must portray it in the light of a science which can be broadened and expanded only by the application of his vision and his talent.

Power the Source of Modern Civilization

Extension of Its Use in Industry and the Home Today Until Every Person in This Country Has at His Command Mechanical Energy Equivalent to That of 50 Men

By George A. Orrok
Consulting Engineer, New York City

Use of Power is rapidly supplanting natural labor; how rapidly few of us appreciate. Where, a few generations ago, each man depended largely upon his own power-producing capacity, today the average person in this country has at his command mechanical power equivalent to 50 men. This change is bringing about many transformations in our mode of living.

Rapid developments in methods of producing mechanical power and in the interconnection of electrical power systems have done much to hasten this development. Also, they have made it necessary to alter our whole conception of our power resources of the future. Falling water in our rivers, for instance, so much discussed a few years ago as being a great source of cheap power, has become of less and less importance each year as our total power consumption has increased by leaps and bounds and as steam-power costs have been cut down.

In the article that follows, George A. Orrok, a veteran in the field of power development whose views concerning it are ever young, sums up the situation as it stands today. His comment is as refreshing as it is valuable, because in his long contact with the technical side of power production he has not lost interest in the human factor. His account of our recent advances in power development and use is written to help the reader appreciate its effect upon present-day civilization. —Editor.

IN JUNE, 1895, thirty-six years ago, George S. Morrison in his presidential address to the American Society of Civil Engineers welcomed the dawn of a new epoch in which the application of mechanical power to industry was the distinguishing feature. He instanced five epoch-making inventions—the use of fire, the domestication of animals, the invention of writing, the use of explosives and the invention of printing—as characterizing the march of progress of man from savagery to civilization, each inaugurating an epoch. The change which followed the ability to manufacture power in any quantity and wherever needed has been, however, much greater than that which followed the previous inventions, since until then man's capacity for work and production had been limited to his own strength plus that of the domestic animals, at best one and one-half man-power per man.

Shortly after Morrison's address and before his death, R. H. Thurston in 1899 had estimated the use of power in the United States at 25,000,000 hp., or about two man-power per capita, and man's capacity for work in this country had been more than trebled. The latest estimates show more than 8 hp. per capita of power-producing machinery in use in this country, while man's productive capacity in this measure is fifteen times what it was at the beginning of the century and about 50 times his unaided individual effort.

Instances illustrative of these facts can be seen today. In Basutoland, in Africa, iron is still manufactured in the native furnaces at a cost of 40,000 man-hours per ton, while our latest furnaces in the Pittsburgh district use only two man-hours per ton. We formerly used candles for illumination which required in their manufacture about six cents worth of a man's or woman's time per candle-hour. Today our 50-watt, 40-candlepower electric lights cost roughly one-tenth of a cent per candle-hour. In transportation the results of such a comparison are even more striking. My own grandfather made a journey from Boston to Petersburg, Va., in the early days of the last century. The trip took six weeks of time, 42 days, and cost about 360 Massachusetts shillings, say $60. The same trip today in a Pullman sleeper takes fourteen hours and costs around $16.

Early Power Consumption Forecasts

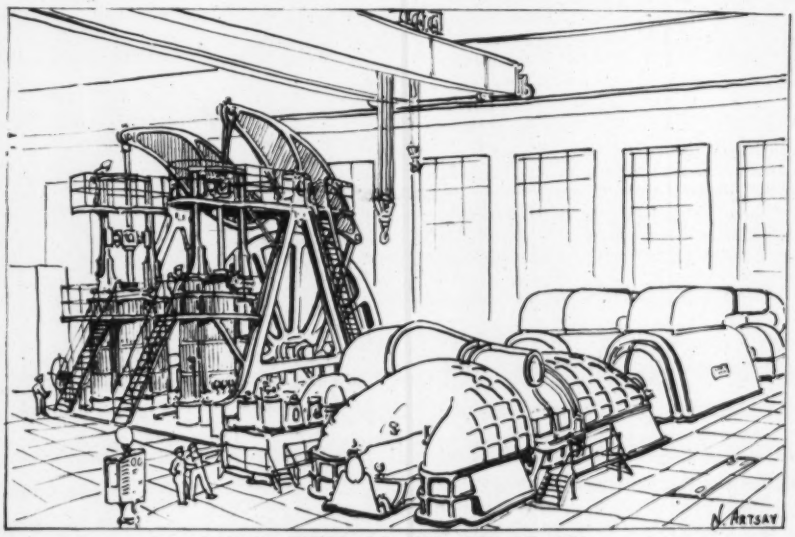
Thurston in 1899 figured that the 25,000,000 hp. of 1900 would double in ten years, but he did not consider the central station and the part which electric distribution would play in the decades to come. Since Thomas A. Edison put into service the first central station at Pearl St., New York, in September, 1882, the central-station output has doubled every five and one-half years instead of the estimated ten years. Mechanical power represents today only about 20 per cent of the total, with central-station outputs about 50 per cent and electrically served industrial plants accounting for the remaining 30 per cent. This total does not include the internal-combustion engine represented by automobiles, tractors and farm engines. The automobile alone accounts for more than 500,000,000 hp. of capacity, although the output of horsepower-hours of work is of much less importance, since the load factor is very low.

In the central-station field today the installation of prime movers amounts to more than 32,000,000 kw., with an output in excess of 83,000,000,000 kw.-hr. Sixty-seven per cent of the houses in this country are now wired for electric service and the companies serve more than 23,000,000 customers, who enjoy the benefits that come from the use of electric energy for light and power. The many improvements in the efficiency of electric generation and distribution have enabled these customers to secure this service at a cost about 30 per cent below that existing in 1914, even though their expenditure for practically everything in the family budget has increased greatly over this same period until today the cost of food, clothing, fuel and shelter has been stabilized at from 60 to 80 per cent above the 1914 level. The use of electric household and shop appliances is wide and largely increasing. It is impossible to secure accurate statistics of the number and power of these labor-saving devices, but it is estimated that more than 50,000,000 are in use and that their number is increasing at the rate of possibly 10,000,000 per year. Among the most useful of these devices is the electric refrigerator, more than 800,000 of which are in use. There are 12,000,000 radio sets in the United States, more than half of which use central-station current. These manifold uses of power all add to the comfort and convenience of our citizens.

It has often been noticed that those industries using the most power pay the best wages. A study of the census reports show that from 1890 to 1925, inclusive, the number of wage earners in the United States nearly doubled, while the horsepower of machinery installed increased more than three and one-half times. This amounts to an increase from 2.1 hp. per worker in 1899 to 4.3 hp. per worker in 1925. The value of manufactured products per wage earner has increased in a little larger proportion, while the wages per worker show the same general increase. In general the wage levels in other countries show the same fact that the level of wages is in direct proportion to the use of power per wage earner.

Water Supplies 12,000,000 Hp.

The earliest users of power in this country were the grist mills and sawmills built on our streams by the early settlers, and from these small beginnings have grown the large hydro-electric installations. The United States Geological Survey estimates that there is 35,000,000 hp. of potential hydro-electric power existing in this country, of which something over 12,000,000 hp. has been developed. Some of this power cost as low as $70 per horsepower to develop, while the larger part cost upward of $150 per horsepower. A number of the larger installations cost as much as $300 to $400 per horsepower, have been in a receiver's hands, and now, with much of the cost written off, are paying interest on what is left of the investment. The remaining 24,000,000 potential horsepower will probably cost in excess of $150 per horsepower and much of it may cost more than $300 per horsepower. Steam power station cost will average about $75 per horsepower, $100 per kilowatt, and under ordinary conditions will produce a kilowatt-hour at about the same cost as a water-power plant costing $200 a kilowatt or $150 per horsepower. At present we have installed about 21,000,000 kw. of steam apparatus. Of the 83,000,000,000 kw.-hr. generated by the central station, about 33,000,000,000 kw.-hr. is hydro-electric generated, while the steam stations furnish 50,000,000,000 kw.-hr.



POWER UNITS OF 1876 AND OF 1928

A sketch to compare a great steam engine of 50 years ago with a great steam turbine of today. In the background is the 1,400-hp. Corliss engine of the Centennial Exposition, 55x55x39 ft. high, weighing 70 tons and running at a speed of 36 r.p.m. Below is the 225,000-hp. American Brown-Boveri turbine of the Hell Gate station, New York, 74x48x48 ft. high, weighing 1,405 tons and running at a speed of 1,800/1,200 r.p.m.

Water Cannot Supply All Power Needs

Many statements are current about the wonderful possibilities of water-power development, and it is easy to show that if all the rain falling in the United States was utilized as power between the level on which it fell and the sea level, the power developed if generated by steam at 2 lb. of coal per kilowatt-hour and 100 per cent mechanical efficiency would represent a coal consumption exceeding the total coal production of the country by about 10 per cent. Vegetation and evaporation necessarily reduce this total by one-half. Long flat slopes and subterranean flows account for another 30 per cent and the Geological Survey estimates the maximum possible output as around 160,000,000,000 kw.-hr., about a 20 per cent utilization of the total rainfall. The actual Survey figures are 20,700,000 kw. at 90 per cent of the time and 32,800,000 kw. at 50 per cent of the time. We actually have about 9,000,000 kw. of hydro-electric power installed, which at the above-mentioned rates should yield somewhere between 72,000,000,000 and 40,000,000,000 kw.-hr., and on this installation we actually get 30,000,000,000 kw.-hr. in a good water year. It would appear that when all possible sites have been developed with costs running $600 to $700 per kilowatt, the possible output from water power might be around 80,000,000,000 to 120,000,000,000 kw.-hr., equivalent at 2 lb. of coal per kilowatt-hour to between 80,000,000 and 120,000,000 tons of coal. Our present use of fuel for all power purposes is around 300,000,000 tons per year.

The output of power in industry and light amounts to the equivalent of about 160,000,000,000 kw.-hr. annually. The central stations furnish 83,000,000,000 kw.-hr., of which steam stations generate 50,000,000,000 kw.-hr. Much progress in efficiency of operation of steam-generating stations has been made in the last ten years and the coal consumption per kilowatt-hour has been reduced from an average of 3.2 lb. in 1919 to 1.84 lb. in 1927 and 1.76 in 1928. With the smaller industrial plant generating its own power, statistics are not as trustworthy, but the 48,000,000,000 kw.-hr. of estimated output must have been generated at an average rate of about 4 lb. of coal per kilowatt-hour. The 32,000,000,000 kw.-hr., equivalent of mechanical power will have a heat rate somewhat higher, say about 6 lb. of coal. Hydro percentages may

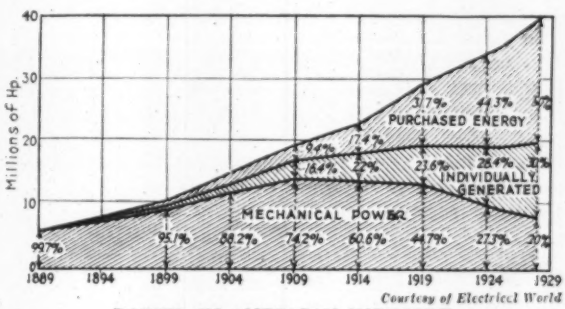
	Output, Billions of Kw.-Hr.	Per Cent Water	Steam Output, Billions of Kw.-Hr.	Coal Rate, Lb.	Coal Used, Tons
Central station	83	40	50	1.84	46,000,000
Industrial	48	15	40.8	4	81,000,000
Mechanical	32	5	30.3	6	91,000,000
Total	163		121.1		218,000,000

be taken roughly at 40 per cent for the central-station companies, 15 per cent for the industrial plants and not exceeding 5 per cent for the mechanical power. A tabulation is given herewith.

The foregoing figures check up well with the coal statistics of the Census Bureau.

Power Use Varies Widely

While the benefits of the electric distribution of power to the home, to manufacturing establishments and to the farm have been so large and far reaching, the power industry itself has benefited by the diversity offered by the widespread use. Load factors have improved and the savings which always follow mass production have



Courtesy of Electrical World

POWER IN AMERICAN INDUSTRY

been substantial. Station ties have been followed by system ties, and regional interconnections are now assured facts. Maps of electric connections and distribution lines show real networks, and in England, where the system is just being introduced, they have been named the "Grid." These interconnections, leaving "superpower" and "giant power" far behind, are now so thoroughly a part of our daily life that only a few months ago most of the United States east of the Mississippi from Boston through Chicago as far south as Pensacola was tied in, synchronized and run as one system for half an hour, and large portions of this area are run in synchronism as the usual operating condition.

It is interesting to note that about one-half of our electric output is generated in the states bordering on the Atlantic seaboard. Three-quarters of the power is generated east of the Mississippi, and about one-eighth is generated on the Pacific slope. The remaining nineteen states with about half the area of the United States generate the remaining one-eighth. Per capita uses of electric current range from 1,610 kw.-hr. per capita on the Pacific slope to 343 kw.-hr. per capita in the Southwestern states. The average per capita use for the whole country is around 720 kw.-hr.

Massachusetts still leads in density of use with around 317,000 kw.-hr. per square mile, with New York, New Jersey and Connecticut using 243,800, 243,200 and 239,000 kw.-hr. per square mile respectively. Pennsylvania comes fifth with 173,000 kw.-hr. per square mile. Ohio uses 120,400 kw.-hr. per square mile, Illinois 111,300, the list ending with New Mexico, with 273 kw.-hr. per square mile. California, with the largest water-power output, comes fourteenth on the list with a concentration of about 46,550 kw.-hr. per square mile, being exceeded by West Virginia, Delaware, Michigan, the District of Columbia, Indiana and Maryland. The average density of use for the whole country is roughly 27,000 kw.-hr. per square mile.

Densities in many smaller areas are necessarily much higher, that of the New York metropolitan district, covering 3,737 square miles, being more than 2,000,000 kw.-hr. per square mile per year. The city of Chicago, 209 square miles in area, has a density of something over 16,000,000 kw.-hr. per square mile. Manhattan Island, with its 21 square miles of area, has a density of use of over 150,000,000 kw.-hr. per square mile. When we come to the most highly developed sections of the city the density of distribution increases to a remarkable extent. One square mile in the center of Manhattan Island has a density of use of more than 330,000,000 kw.-hr., with a demand of about 108,500 kw. for commercial light and power alone, the power used by the transportation systems not being considered. Four city blocks in a light manufacturing section aggregating one twenty-fifth of a square mile in area demand at the rate of 337,000 kw. per square mile and have a density of use 1,180,000,000 kw.-hr. per square mile per year for the commercial service alone, about 45,000 times the average density of use in the country as a whole. The maximum density of use of electric power which has come to the writer's notice is about 100 kw.-hr. per square foot per year, which is more than double the density in the four city blocks cited above. Many manufacturing establishments use between 20 and 80 kw.-hr. per year per square foot of space occupied. It would appear that concentrations of this order are not likely to be substantially increased in the future.

Per Capita Use Still Increasing

The per capita use of electric power with its present value of 720 kw.-hr. has been gradually increasing and probably will continue to increase for many years. There are still numerous services that in the future will be performed by mechanical and electrical devices which already in many lines have raised the curse of Adam and added greatly to the comfort and happiness of our people. I believe a per capita use of 1,500 kw.-hr. per year is within the range of possibility and I am supported in this belief by statements in the technical press that 3,000 kw.-hr. per year per domestic customer is now within the efforts of a good sales force.

Improved Engines Cheapen Power

Meanwhile with the increasing use and cheapening of power the steam engine of James Watt, of nine nominal horsepower, has grown into the 1,400-hp. Centennial Corliss engine of 1876 and the 8,000-kw. Allis engines of 1904. The turbine of Hero, a mere philosophical experiment, has grown through the work of DeLaval, Parsons, Curtiss, Rateau and Westinghouse into the 30,000- to 50,000-kw. standard machines, the 160,000-kw. two-shaft turbines of Hell Gate and the 208,000-kw. three-shaft machines of State Line. The atmospheric engines of Newcomen, which Watt improved by adding the condenser, became the 200-lb. pressure engines of 1900, and today steam has been used commercially in every-day service at or about the critical pressure of 3,200 lb., and the steam boiler, with the aid of the inventions of Bessemer and Siemens, of Nasmith and Maudsley, of Holley and Fritz, of Kraft and Armstrong, now stands the higher pressure as easily and with much more safety than did the early work of Watt, Trevithick and Stevenson.

The gas engine of Otto and Clerk has been built up to 5,000-hp. sizes and improved so that the use of liquid fuel became satisfactory and cheap, while the discovery of gasoline and the invention of the automobile has multi-

plied the use of internal combustion engines until today they represent more than half of the prime movers used in this country. The diesel motor, conceived to use powdered coal as a fuel, soon adopted the heavy oils as its own field and now develops substantial amounts of power, the largest single unit being the 15,000-hp. Hamburg installation. Driven by the analogy of the steam turbine, inventors have turned their minds toward the gas turbine, which has been successfully used in small sizes and which now appears to have some chance of success in the larger sizes. The thermal efficiency of all the internal combustion motors is very attractive, going far ahead of steam apparatus, but the installation costs remain high and commercial efficiencies still favor the steam plant with its 50 per cent of heat rejected at the low level, while the internal combustion apparatus may reject as little as 30 per cent in the exhaust gases but must suffer an additional loss in the jacket cooling system.

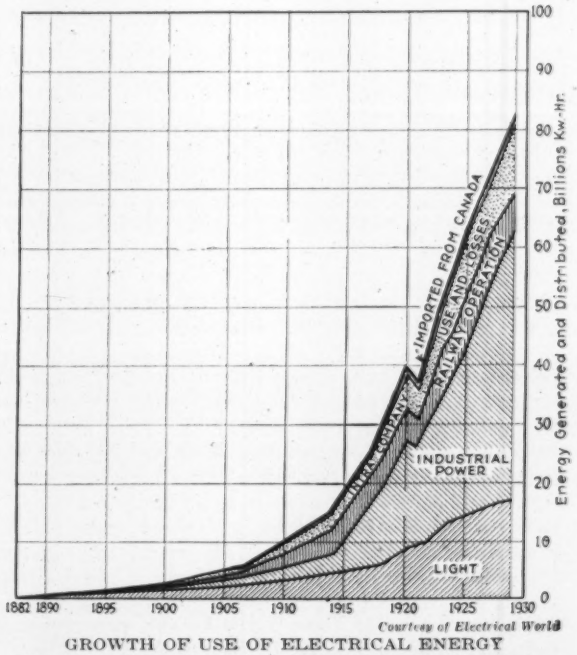
Wholesale and Retail Costs Low

In his paper before the British Association for the Advancement of Science in 1926 Sir John Snell puts fixed charges and fuel cost as each about 45 per cent of the total cost of generating steam-electric power. In the hydro-electric field fixed charges may easily amount to 90 per cent, but the total cost is generally in favor of the hydro-electric when compared with steam totals. Unfortunately nature has very rarely placed good water powers in localities where ready markets for power are found, and in consequence transmission costs must be added to the generating cost for most hydro-electric installations. Roughly for the country at large and excepting certain favored localities such as Buffalo, the cost of generating electric power may be taken as around 8 mills when hydro-electric transmission costs are taken into account. Many large high load factor contracts for power have been made at slightly above this figure, say at 0.85 cent. Smaller blocks of power up to 4,000,000 to 5,000,000 kw.-hr. per year may be usually placed at 1.2 to 1.6 cents, depending on load factor and distribution costs. The ordinary wholesale customer using 1,000,000 to 3,000,000 kw.-hr. per year of low load factor low-tension current may pay from 2 to 5 cents, depending on the type of service and continuity demanded. The average retail consumer using, say, 1,000 kw.-hr. per year may pay 5 cents a unit on an alternating-current overhead service or double that rate on an underground direct-current service protected by storage batteries giving absolute security. Even with rates of this level there are many thousand customers who pay between $10 and $20 per year, an amount scarcely sufficient to pay interest on the cost of the service installation and meter and the cost of meter reading, accounting, billing and collecting, to say nothing of the cost of generation and distribution.

The light and power industry has a capital investment of about $10,300,000,000, which is increasing at the rate of about $800,000,000 per year. The gross revenue amounts to about $1,908,900,000, giving a turnover about once in five and one-half years. The average return per kilowatt-hour generated is around 2.3 cents. It is interesting to compare the light and power business with its capital turnover of once in five years with such a line as automobiles, where the investment may turn over four to six times per year, each turnover bringing in a profit to the capital invested, the workman and the public.

The early economists of the classical and Marxian schools laid stress on the unequal distribution of wealth and have proposed many remedies, some reasonable and some drastic, looking toward the relief of the "submerged tenth" and the abolition of poverty. Unions and protective associations have been organized, industrial battles have been fought, even dynasties have been overthrown, in this endeavor. Meanwhile the inventive genius of man and the law of evolution have found the way, created the machinery and accomplished the result. Prosperity, the increase of productivity of a people, carried to the *n*th degree, has been made possible by the development of mechanical power; has been made general in this country by electrical distribution; until today each inhabitant, served by his 50 mechanical slaves, who eat only when they work, has the natural resources of the world at his command. The "submerged tenth," the bugaboo of the nineteenth century, has disappeared, and not alone our own people but the immigrant millions coming to these shores are enjoying substantial and mental possessions which have been the dreams of past civilizations and ages.

In a country where three-quarters of the families own their homes, where one-third of the population has a savings bank account and each family owns at least one automobile, where silk stockings and fur coats are worn alike by the wife of the millionaire and by the scrubwoman, where practically every grown person is a capitalist and where 50 man-power of power-producing machinery is in use per capita, the future of the United States is indeed bright. Agitators may rail, the pale pinks and intelligentsia will probably continue to find fault with things as they are, reformers will preach change, but sound common sense sees the increasing use of power, which brings with it more production, more leisure for education and enjoyment and a more general diffusion of civilization and its ideals throughout this country and the world which has never been seen before in the history of man's progress.


IMPORTED FROM CANADA
USE AND LOSSES
RAILWAY OPERATION
INDUSTRIAL POWER
LIGHT
1882 1890 1895 1900 1905 1910 1915 1920 1925 1930
0 10 20 30 40 50 60 70 80 90 100
Energy Generated and Distributed, Billions Kw.-Hr.

Courtesy of Electrical World

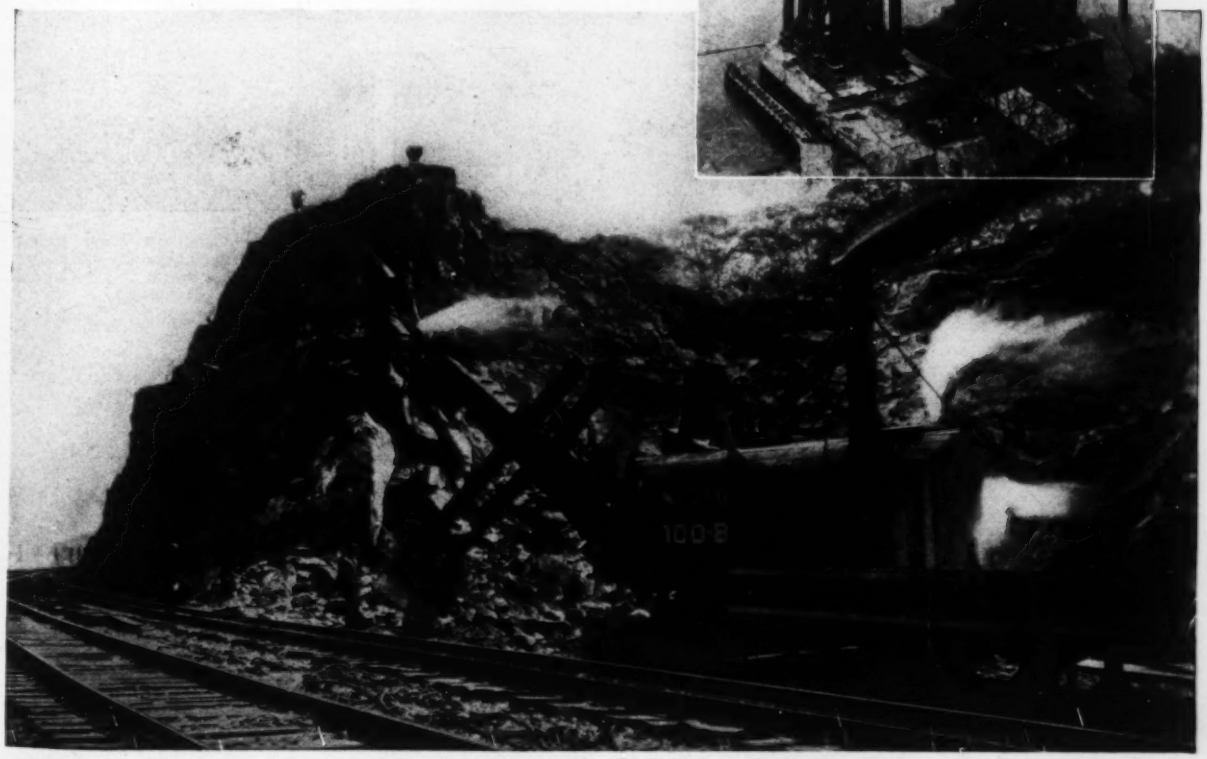
GROWTH OF USE OF ELECTRICAL ENERGY

Comparison of the uses of electrical energy since the beginning of its development. The rapid increase in the use of such power in industry is notable.

SOME CONSTRUCTION PROJECTS OF 1928

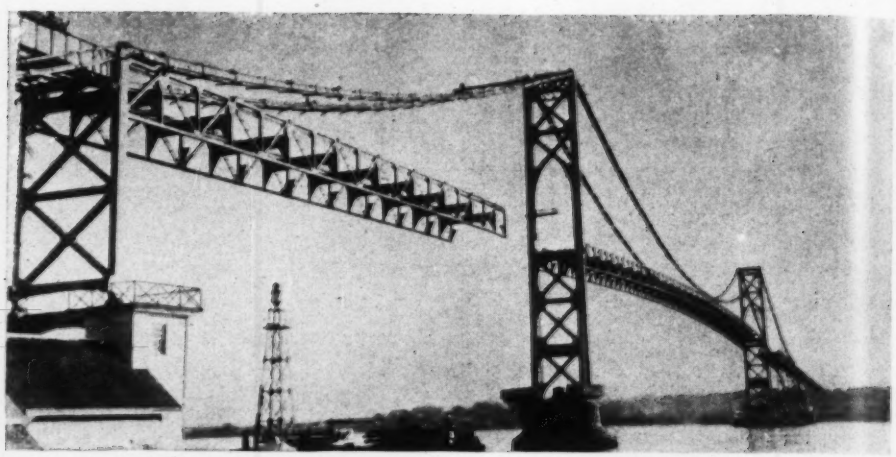
A Pictorial Survey

Right: New Jersey tower of mighty 3,500-ft. suspension bridge over Hudson River, New York City. When completed towers will rise 600 ft. above water level

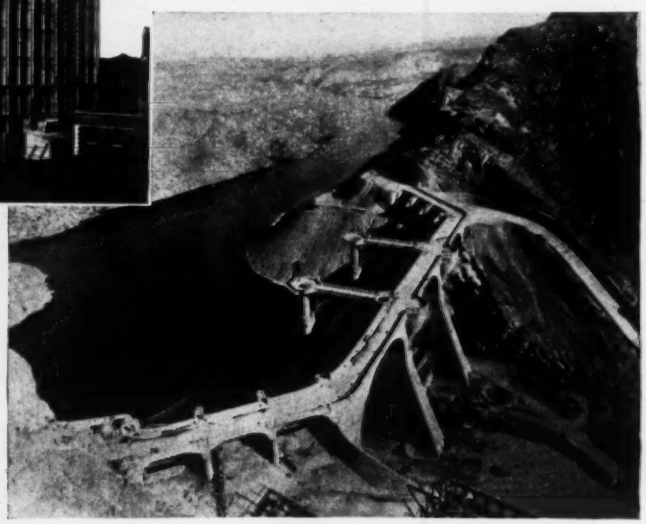


Heavy rock cut on New York Central's four-tracking project, 10 miles long, south of Beacon, N. Y. Work comprises one new tunnel, two enlargements and 750,000 cu.yd. of rock excavation.

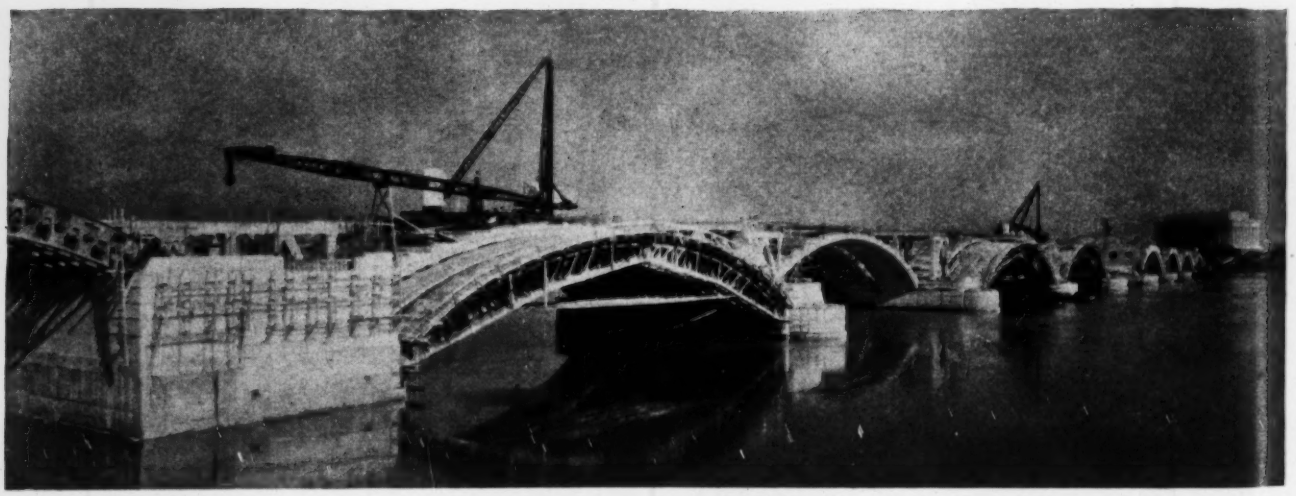
Above: 24-story Southwestern Bell Telephone Building, highest structure in Kansas City, Mo. Twelve stories added last year.



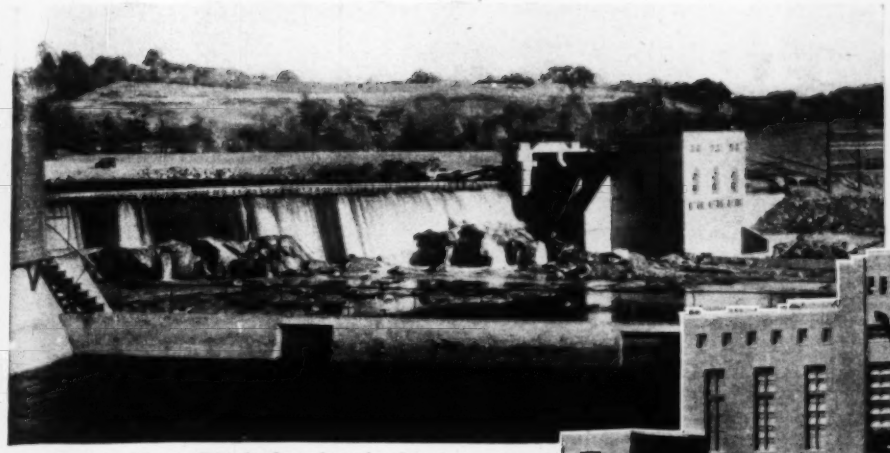
Above: Mount Hope suspension bridge, Bristol to Portsmouth, R. I., 1,200-ft. span. *Below:* Coolidge multiple dome dam on the Gila River, Arizona. Three domes 180 ft. high and 254 ft. wide.



Reinforced-concrete shed protects new Southern Pacific Cascade line in Oregon against snow and rock slides.

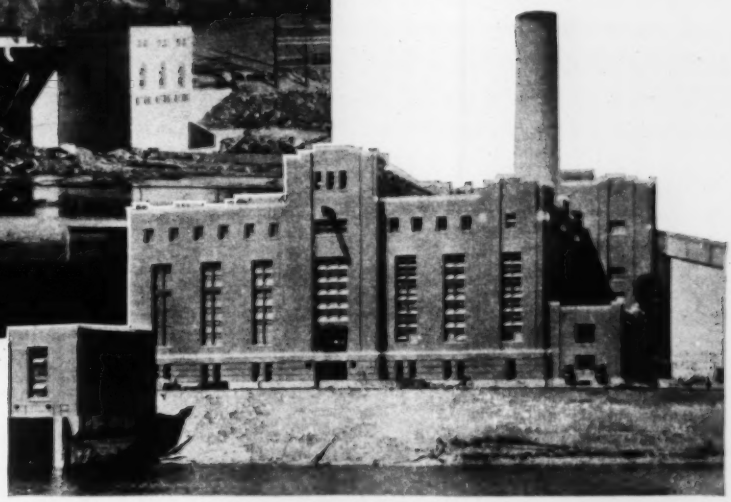


Arlington memorial bridge across Potomac River, Washington, D. C. Lincoln memorial on right.

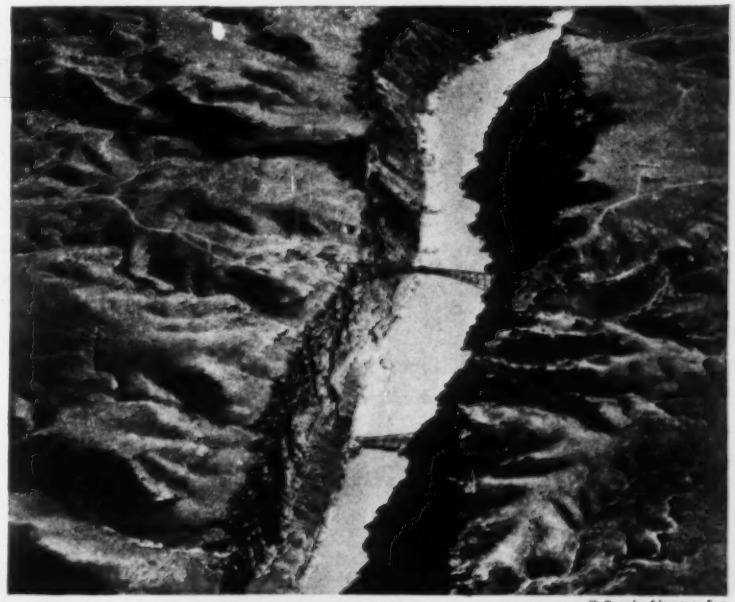


Above: Deep Rip hydro-electric development, Central Maine Power Company, Lewiston, Me.

Below: First unit, Powerton power plant of Superpower Company near Pekin, Ill.



Above: West portal, 8-mile Cascade Tunnel, Great Northern Railway. *Right:* 616-ft. steel arch highway bridge over Marble Canyon, Lee's Ferry, Ariz.



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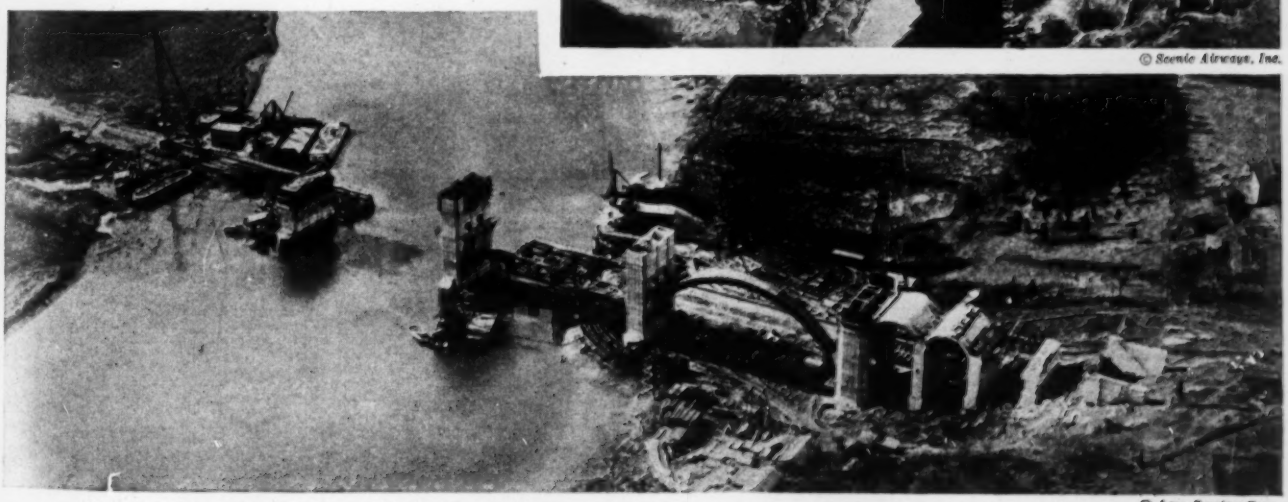

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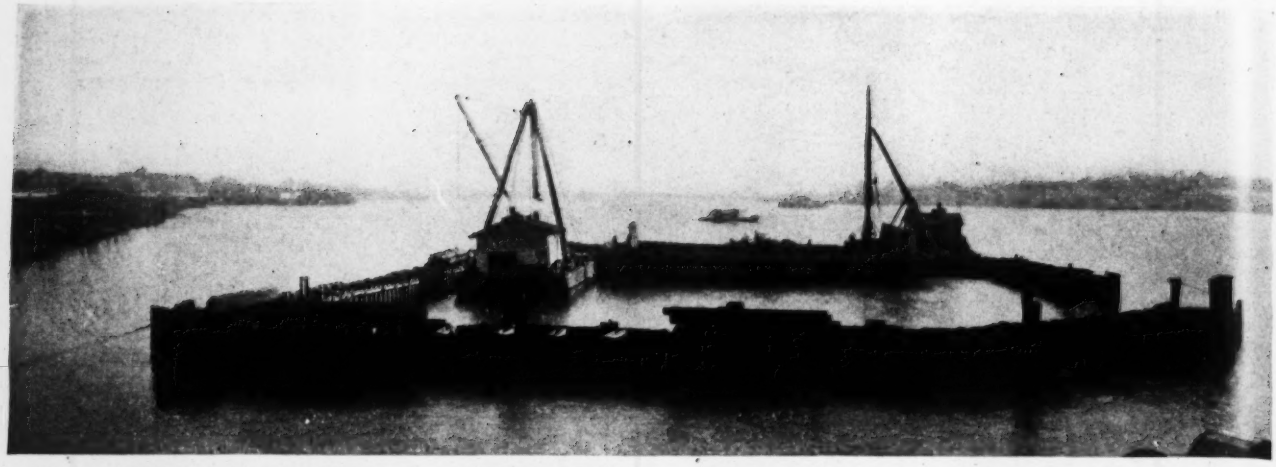
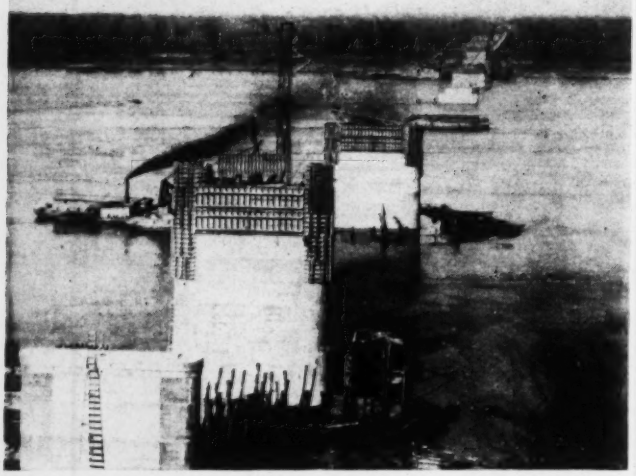
New Jersey state highway bridge over Raritan River near New Brunswick. Arches span 202 ft.

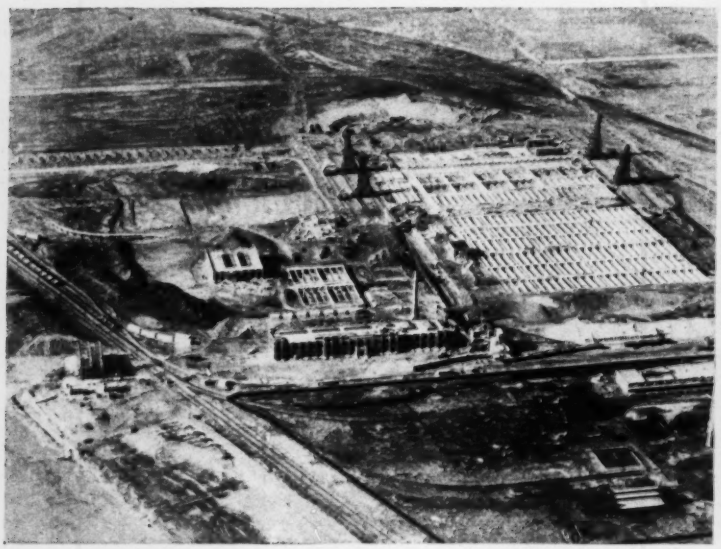


Above: Cofferdam for Bayonne abutment, Kill van Kull 1,675-ft. steel arch bridge, New York.

Below: Jordan dam on Coosa River, Alabama, for Alabama Power Company.



Above: Piers for combined railroad and highway bridge across the Mississippi at Vicksburg.



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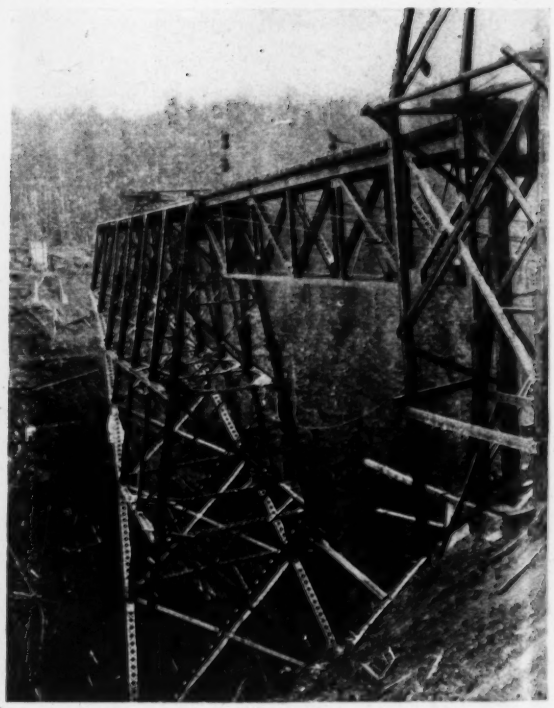
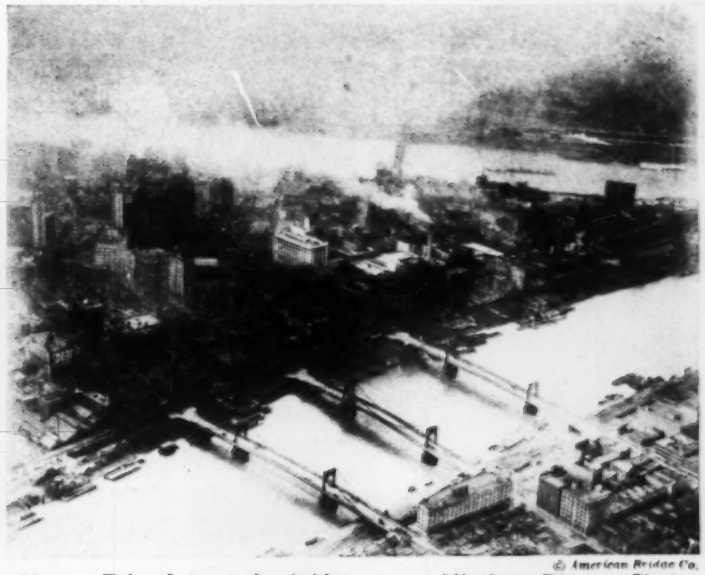
Chicago West Side Imhoff tanks, largest sewage-works in world.

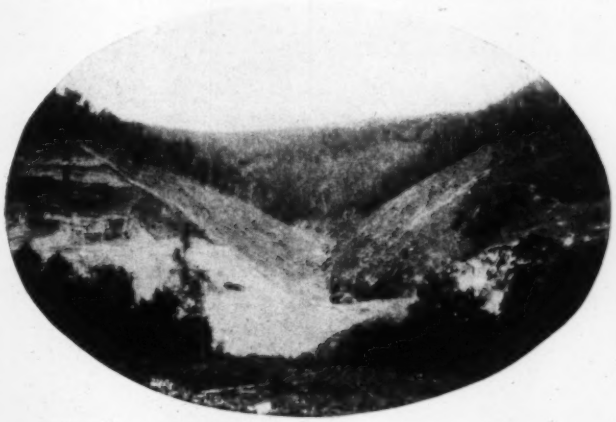


Single-track logging bridge over Vance Creek, Washington.

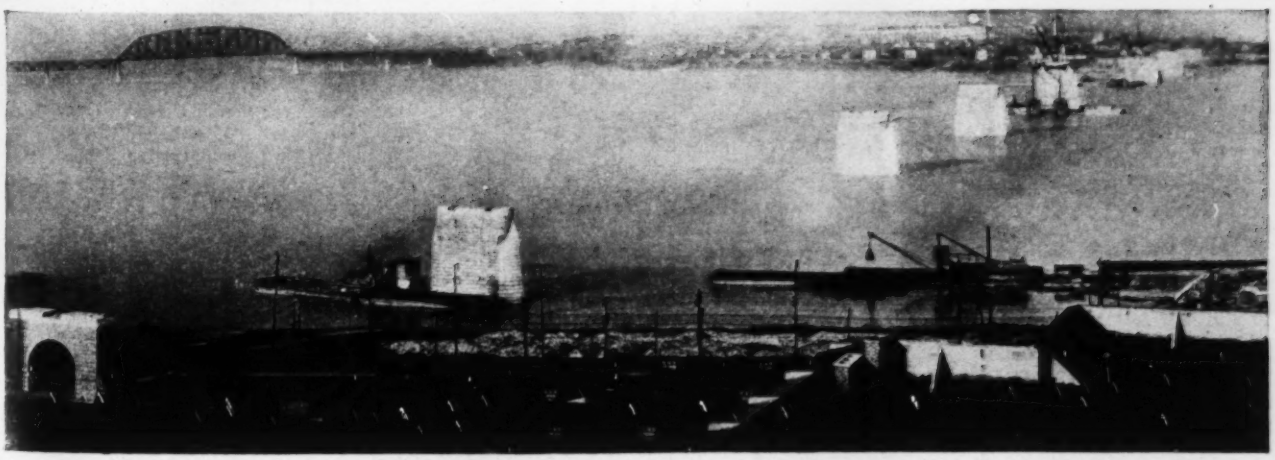


Above: Trio of suspension bridges across Allegheny River at Sixth, Seventh and Ninth Sts., Pittsburgh.

Above: Pardee dam on Mokelumne River, California. *Below:* Site of Cobble Mountain hydraulic-fill dam, looking downstream. Springfield, Mass., water-supply project. Dam will be highest earthfill in world, 245 ft. Clearing shows limits of fill.

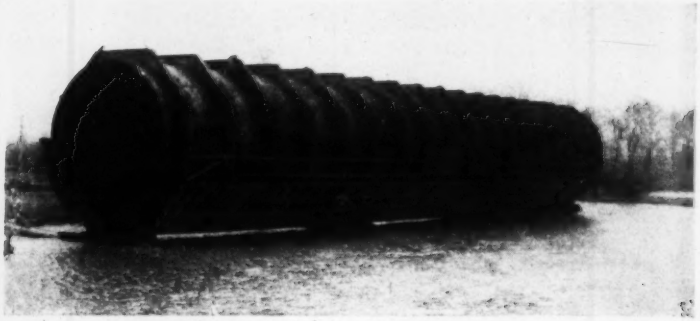


Above: New North Station, Boston & Maine Railroad, Boston, Mass.

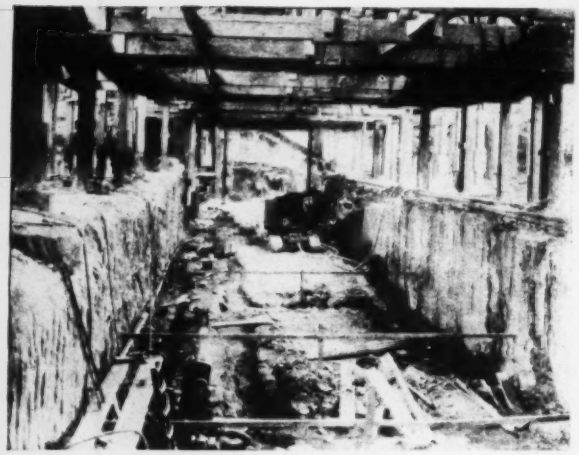


Piers for highway bridge over Ohio River, Louisville, Ky.

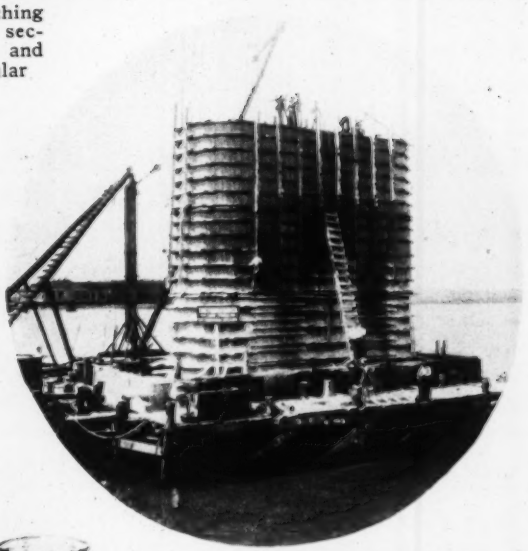
Above: East approach of multiple arch concrete highway bridge over Seekonk River, Providence, R. I.



Above: Launching first steel tube section, Detroit and Canada vehicular tunnel.

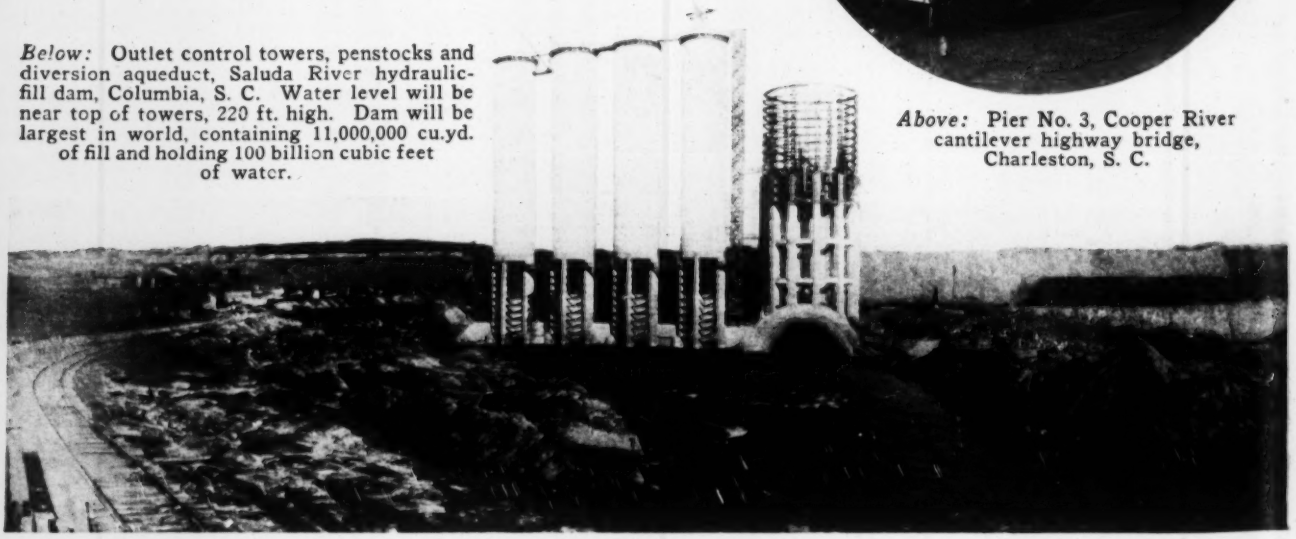


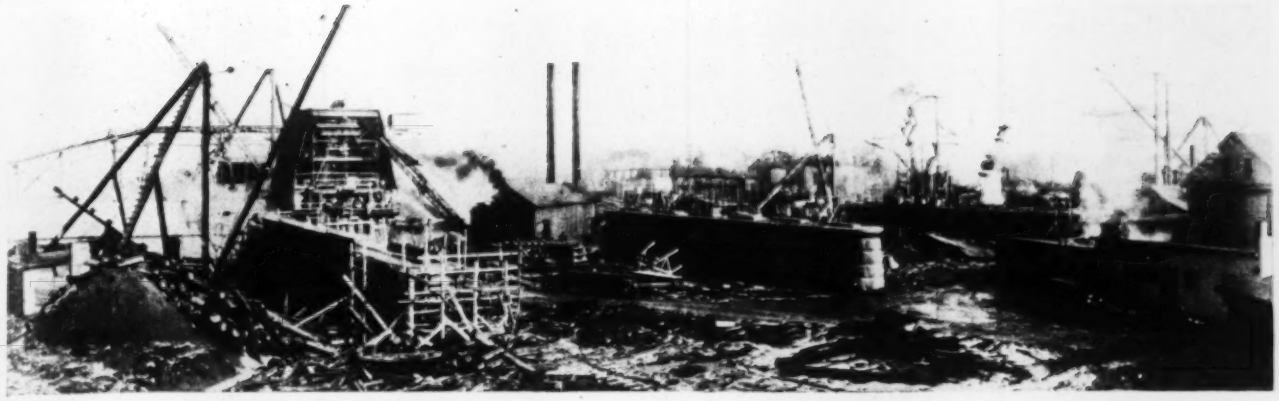
Above: Heavy section of New York's new subway system, Route 101, Sec. 4. Ten tracks at this point, eight on upper level, two on lower. Lower level 65 ft. below street.



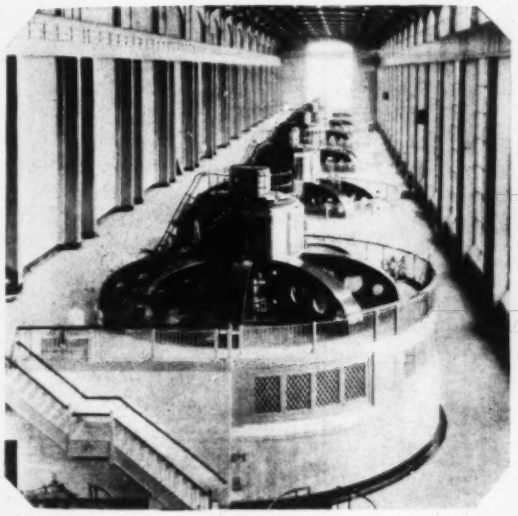
Above: Pier No. 3, Cooper River cantilever highway bridge, Charleston, S. C.

Below: Outlet control towers, penstocks and diversion aqueduct, Saluda River hydraulic-fill dam, Columbia, S. C. Water level will be near top of towers, 220 ft. high. Dam will be largest in world, containing 11,000,000 cu.yd. of fill and holding 100 billion cubic feet of water.

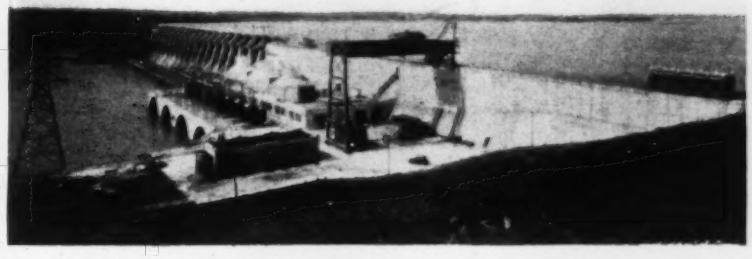




Above: East approach, Seekonk River Bridge, Providence.



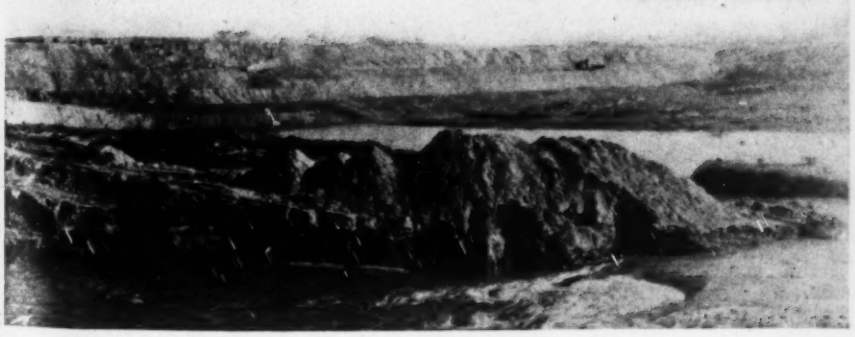
Left: Turbine room, Conowingo hydro-electric power station, Conowingo, Md.



Above: Norwood dam on Yadkin River, N. C., Carolina Light & Power Company. Dam is 86 ft. high and 1,553 ft. long. *Left:* Starved Rock lock and dam, Illinois River near La Salle, Ill.

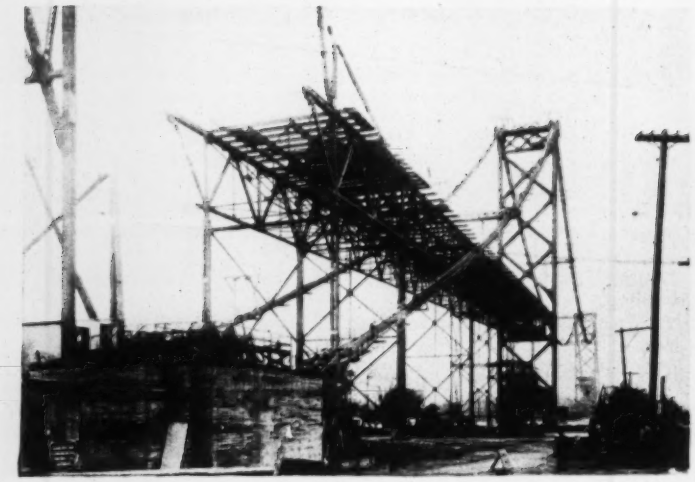
© Chicago Aerial Survey

Below: Saluda dam, Columbia, S. C.



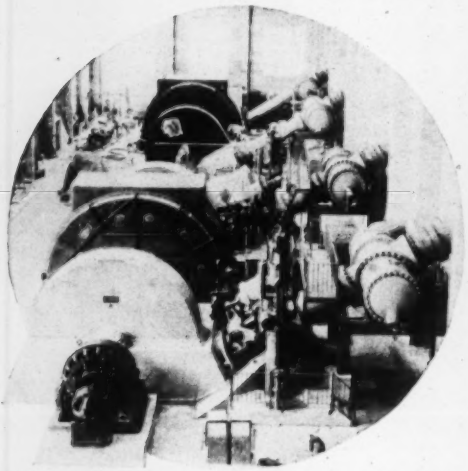
Wide World Photo.

Above: 56-story Chanin Building at night, New York City.



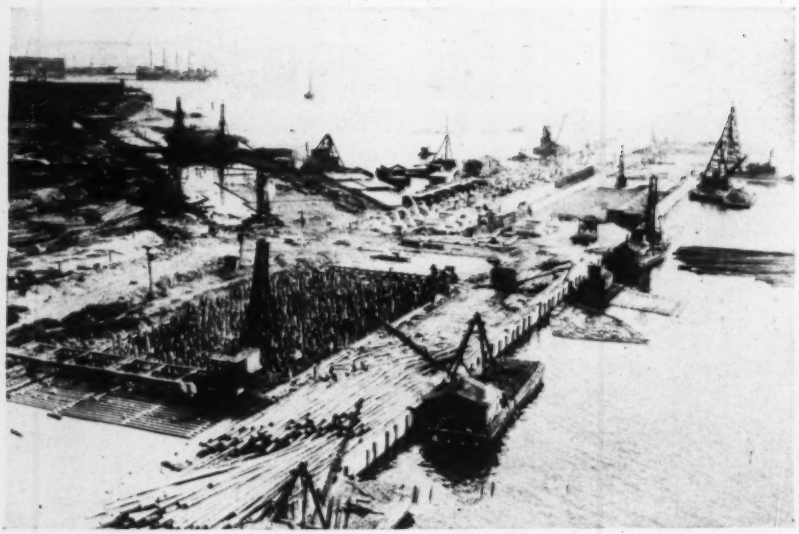
Above: Detroit River international 1,875-ft. suspension bridge showing Canadian anchorage.

Above: East portals, old and new Musconetcong tunnels, Lehigh Valley Railroad, New Jersey.

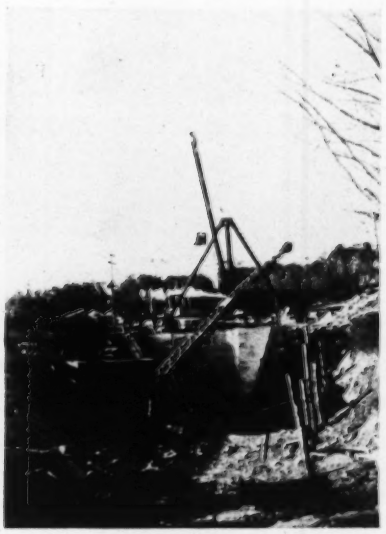


Above: Units for operation under static head of 2,420 ft., Big Creek 2-A power plant, California.

Above: Outlet of diversion tunnel, Owyhee dam site, Washington, looking upstream.



Baltimore Municipal Dock Improvement. Pier extends 1,700 ft. into bay; marginal wharf will be 950 ft. long.



Outlet shaft of Boston's new 14-mile water tunnel.

Has Registration of Engineers Accomplished Anything?

A Survey of the Situation as a Background for Two Questions: Does the Progress So Far Made Warrant Further Confidence in the Plan and Has $1,260,000 Been Too Big a Price for the Benefits Received?

By C. J. Ullrich
Consulting Engineer, Salt Lake City

WHAT has been accomplished to date by the registration of engineers? Have registration laws been a benefit or merely an added burden to the profession? Engineers and engineering societies differ as to the answers to these questions. There are those who are optimistic over the results so far obtained. Others are decidedly skeptical, while some even think the laws have been a detriment and should be repealed.

To determine the present-day status of registration of engineers and its effect on the public and the profession, the writer canvassed, by letter, the secretaries of the state boards of engineering examiners in all states having an engineers' registration law. The data that follow are based on the replies received.

Certain provisions, such as the grandfather clause, examinations, enforcement, revocation of certificates, exemptions, renewal fees, amendments, reciprocal registration and the like, are the matters around which the success of the laws revolves. In considering these various elements, the fact must not be lost sight of that registration is essentially for the public interest—to safeguard life, health and property. If it were otherwise—that is, for the interest of the profession itself—it would be class legislation and therefore unconstitutional. Nevertheless, if it is good for the public it is good for the engineer.

LAWS relating to the registration of engineers are today on the statute books of 25 states. Such laws are also in force in seven of the nine provinces of Canada. Prior to 1917 only four states had enacted such laws. Of these states the California law applied only to surveyors, while the Illinois law embraced only structural engineers. In Idaho and Wyoming the law embraces only surveying and civil engineering.

Between the years 1917 and 1922 a sentiment for registration swept the country, with the result that nineteen states enacted registration laws during that period. Since 1922 only three states have been added to the list. At the present writing there is considerable sentiment in favor of registration acts in the states of California and Missouri. Most states that have enacted a registration law have made their law compulsory and applying to all branches of the profession; in others the law is optional.

In this article Mr. Ullrich reviews the whole structure of present registration enforcement. He makes some conclusions from his survey, but the important thing is for every engineer to think the problem through for himself. Like every live subject it probably requires the elimination of a mass of dead ideas.

Evils of the Grandfather Clause

Every registration law, with the exception of the amended South Carolina law changing from optional to compulsory registration, includes a provision allowing all persons who have practiced engineering for a certain number of years immediately prior to the enactment of the law to become registered within a certain time after the law becomes effective, without taking an examination. This provision, termed the "grandfather" clause, is generally considered a legal requirement in order to make the law constitutional.

It has been the experience of every state that the original number of registrations under the grandfather clause far exceeded the number now registered. In some states as Indiana this falling off has been only 10 per cent, whereas in other states, notably Colorado and Idaho, it has been as high as 50 per cent. It seems certain that much of this decline is due to a lack of interest on the part of engineers who took advantage of the grandfather clause and then failed to renew their certificates of registration after they expired. Yet many of the incompetents admitted under the grandfather clause are still practicing and will continue to practice for some time, especially in the smaller rural communities. There is no way to eliminate this class except by revocation of their certificates in case complaint is filed against them for incompetency. This to date has been a very rare occurrence. South Dakota attempts to hold this class of registrants in check by refusing them use of their certificates outside the state.

The method of examining applications for registration differs widely. In some states written examinations are mandatory for all applicants, whereas in other states the Board of Engineering Examiners is vested with discretionary power as to whether the applicant is to be given a written or an oral examination or to be admitted on his professional record. The law of several states when first enacted required references as to character, education and training as the sole qualifications for registration. Practically all these states have amended their laws so that they may now examine an applicant not only in the branch of engineering that he practices but also as to his knowledge of the fundamental principles of engineering and his general education.

The writer also finds that the character of the examinations varies greatly in the different states, in some being unusually elementary. *The trend generally is toward a higher standard.* Boards have found that they must insist on certain minimum requirements and these must be high enough to eliminate the incompetents and

those detrimental to public health and safety. On the other hand, many of the boards realize and take into consideration the fact that no set of examination questions will truly reflect the competence of all applicants, as there are many men who in practice have developed that skill and judgment which leads to sound conclusions who could be "flunked" by an examination that a college student might pass with ease.

Florida's experience has been that the more exacting the examinations the higher the type of registrants. It also seems to be the rule that better support is accorded the law by the members of the profession if the examinations are exacting.

In some of the states the number of rejections have been few, whereas in other states they have been surprisingly large. Virginia reports more than 400 applicants rejected. Florida reports rejection of 156 applicants, or 10.4 per cent of those that have applied for examination. Michigan reports a large number rejected during the past nine years. Although full figures are lacking, the indications are that more than 3,500 persons have been rejected all told in the several states.

Reciprocal Registration Growing

The most serious objection in the past to registration laws has come from engineers practicing in several states, each requiring a registration certificate. To overcome this objection and not embarrass this type of practitioner a number of states have adopted a reciprocal registration clause whereby a person registered in one state may become registered in any other state with which that state has reciprocal agreements without taking an examination.

Importance of Renewal Fees

Fees for annual renewal of certificates vary from $1 to $5. Iowa started out with no renewal fee and soon found that its registration fund was becoming depleted, so amended its law to provide for a $2 renewal fee. On the other hand, several states started out with a $10 renewal fee, but soon reduced it to $5. West Virginia still has a $10 renewal fee, but considers it high. It has been demonstrated that the entrance fees for registration are not in themselves sufficient to maintain the expenses of administering the law. In Colorado the renewal fee of $5 has built up a surplus of which more than $25,000 has been spent for the creation of an engineering library.

Evils of Exemptions

Most registration laws exempt certain classes of engineers from registration, including army engineers, engineers in the employ of the federal government, and practicing engineers from other states, provided their practice within the state does not exceed 60 days in any one calendar year. The Hawaiian registration law goes to the extreme in this respect, by exempting all engineers employed by the territory, county and municipalities.

Strengthening the Laws

It is important to note that no state that has enacted a registration law has repealed it. On the other hand more than one-half of the states have amended their registration laws since they were first enacted, and in every instance these amendments were made for the purpose of strengthening or correcting the law.

The constitutionality of engineers' registration laws has been tested in several states, Tennessee being the latest, and in all cases with the exception of Pennsylvania the law has been upheld. In Pennsylvania, where the law was declared unconstitutional on a legal technicality, it has been re-enacted and is in force today.

STATES HAVING REGISTRATION LAWS

State	Compulsory	Optional	Engineer	Surveyor	Law Effective	Entrance Fee Eng.	Entrance Fee Sur.	Renewal Fee Eng.	Renewal Fee Sur.	Number of Registrants Jan. 1927
Arizona*	×		×		1921	15	10	5	5	267
Arkansas	×		×		1925	25		5		219
California		×		×	1891		10		0	1,600
Colorado	×		×	×	1919	15	15	5	5	500
Florida	×		×		1918	25		5		875
Hawaii	×		×	×	1923	15	15	5	5	180
Idaho	×		×	×	1919	10	5	2	2	300
Illinois	×		×		1916	15		1		840
Indiana	×		×	×	1921	25	25	5	5	909
Iowa	×		×	×	1919	25	25	2	2	1,310
Louisiana	×		×	×	1908	25	25	3	1	425
Michigan	×		×	×	1919	20	20	1	1	1,426
Minnesota		×	×	×	1921	25	10	5	2	603
New Jersey	×		×	×	1922	25	25	1	1	1,836
New Mexico	×		×	×	1917	5	5	0	0	250
New York	×		×	×	1920	25	25	1	1	8,500
North Carolina	×		×	×	1921	25	10	5	5	752
Oregon	×		×		1919	15		3		1,682
Pennsylvania*	×		×	×	1921	20	20	1	1	3,284
South Carolina	×		×	×	1922	25	25	1	1	283
South Dakota	×		×	×	1925	25	15	5	5	150
Tennessee	×		×		1922	25		5		300
Virginia	×		×	×	1920	25	25	5	2.50	975
West Virginia		×	×		1921	20		10		239
Wyoming	×		×	×	1907	15	15	2.50	2.50	152
					Canada					
Alberta		×								
British Columbia	×									
Manitoba*										
New Brunswick*										
Nova Scotia	×		×		1920					
Ontario		×			1922					450
Quebec	×		×	×	1920					1,200

* No report received.

An accurate statement of the cost of administration of the law in the several states cannot be given. However, some fairly close estimates can be made. In Minnesota the unit cost has been $43 per registrant over a period of seven years; in Louisiana $71 in twenty years; in New Mexico only $5. From all the figures it appears that about $1,260,000 has been spent to date in administering the laws of the several states.

Enforcement—Effective and Poor

The enforcement of registration laws is in a word spotty. In some states the Board of Engineering Examiners has not the power to initiate proceedings against violators of the law, such proceedings arising from private initiative. Where the boards have such power, some have been rather lax in enforcing the law, while others have enforced it without fear or favor.

Florida a year ago employed a deputy to canvass the entire state for violators of the registration law, which resulted in the registration of a number of engineers without the necessity of legal action. In South Dakota the board has had several trying experiences with politicians who sought to force it to grant registration to certain applicants. The board, however, stood its ground, rejected the applicants for good cause and won out. In Indiana the board prior to 1927 had not the right to institute proceedings against violators of the law. In that year the law was amended to give the board that right, and it has since followed up all complaints of violation brought to its attention. Iowa, North Carolina, New Jersey, South Carolina, Virginia, West Virginia and Wyoming are all trying to enforce the law. Colorado, Idaho and New Mexico report a rather lax condition in law enforcement. In New York the enforcement of the law is not vested in the Board of Engineering Examiners but in the Department of Education.

The interest shown by the various states in their

registration laws constitutes a fairly good index as to the value of the law. In Arizona, Iowa, Indiana, New Jersey, North Carolina, Oregon, South Carolina, South Dakota and Wyoming the engineers are well pleased with the way in which the law is working out and give it their enthusiastic support. Colorado, Idaho, Michigan and New Mexico report only a lukewarm interest in the law by engineers after having become registered and in nearly every state there is reported a lack of interest on the part of the public.

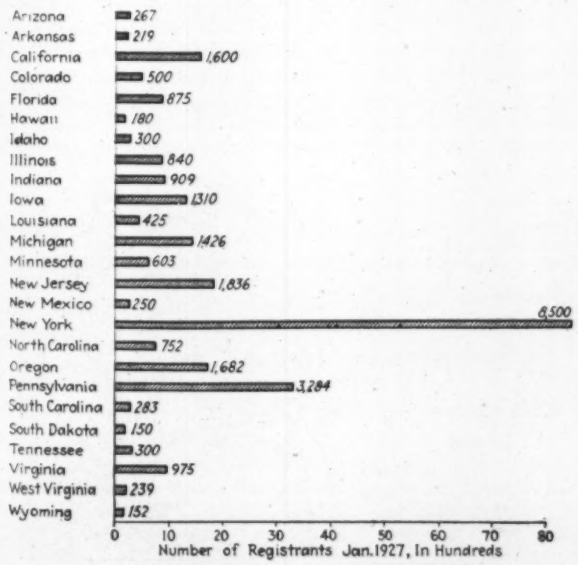
On the other hand, the employers of engineers are showing a keener interest in registration as time goes on. Counties and municipalities generally take the law seriously and co-operate with the state boards in enforcing the law. In several states the board of engineering examiners are carrying on an active campaign of education in behalf of the registration law, furnishing employers of engineers with literature on registration, lists of registered engineers, etc.

Criticism of registration laws comes mainly from engineers who have violated the provisions of the law for which they have been called to account, or who have been dissatisfied with the decisions of the board; also from non-resident engineers who come into the state to practice.

Does Registration Really Return Benefits?

Although the enactment of engineers' registration laws is predicated primarily on the protection or welfare of the general public, it must be admitted that benefits come to the profession as natural concomitants of the benefits derived by the public. If an engineer is disqualified through incompetency or unprofessional conduct, certainly the profession is as much benefited as is the public. Likewise, if the public is served with a higher type of engineer through registration laws, the profession is equally benefited by the elevation of the ethical standards of the profession.

Almost every state reported a number of tangible benefits from the registration laws. In Iowa county engineering work is awarded on a competitive bid basis. Since the enactment of the registration law many incompetent men who competed for this class of work have become disqualified or have dropped out, eliminating much cut-throat competition. Other examples of tangible benefits reported are political preference shown registered engineers at the polls in Minnesota, where registration is optional.



A GRAPHIC VIEW OF REGISTRATION

The intangible benefits derived from registration laws are rather hard to define specifically. Keeping surveyors who are incompetent as engineers from aspiring to practice engineering without first qualifying themselves, requiring a higher standard from men who wish to follow engineering, building up the morale of the profession and placing it on a higher ethical basis are all intangible yet substantial benefits to public and profession. In some commonwealths state departments are exempt from the operation of the registration law, yet in several of these states we find state officials insisting that all their engineers in advanced positions hold registration cards. Many engineers employed by railroads and other public utilities have voluntarily appeared before examining boards to take examinations since they have found that their chances for advancement with their organizations are strengthened by being registered. This corresponds with the statement previously made that employers of engineers are taking an active interest in registration. It has also been found by engineers in some states that registration carries weight with courts when engineers appear as experts. In West Virginia, where registration is optional, the law has worked to the benefit of registered engineers and to the disadvantage of non-registered engineers.

Registration in Canada

Reports from the several provinces in Canada having registration laws indicate the same general trend as in the United States. Where the law is rigidly enforced good results have followed, but where the enforcement has been lax not much has been accomplished.

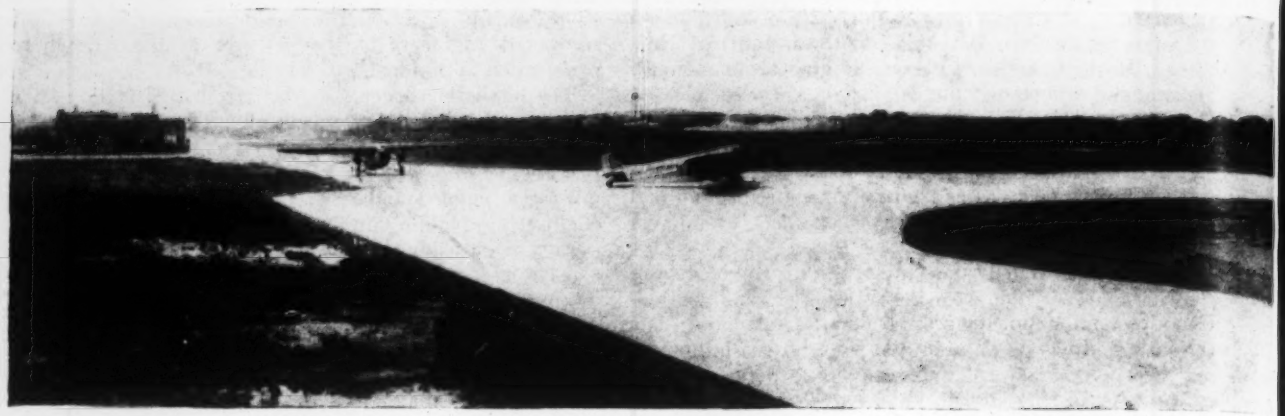
The registration law of Quebec has practically made engineering a closed corporation within the province. Every person who calls himself an engineer or who practices engineering must be a member in good standing in the Corporation of Professional Engineers of Quebec. Only graduates from recognized engineering schools are admitted to membership in the corporation without an examination. Only bona fide residents of the province can obtain a license. Outsiders can act as consulting engineers provided they have qualifications equivalent to requirements of the corporation and have associated with them a member of the corporation. The law has worked out very satisfactorily and the report shows that both the public and the profession have been greatly benefited. There are approximately 1,200 engineers on the registration roll in this province.

In Alberta registration is not restricted. The report from this province states that registration has brought about a greater professional consciousness among the practicing engineers and a gradual improvement in the attitude of the public toward engineering as a profession.

In Ontario the law is optional, although two-thirds of those qualified have become registered.

In Nova Scotia the registration law has been on the statute books since 1920, but not much has been accomplished due to early mistakes in permitting incompetents to be registered, which resulted in hostility toward the law by some engineers and legislators. In spite of this handicap the act is considered far better than no registration act at all.

From British Columbia comes the report that the registration act is looked upon with indifference by the public but has had good support from the profession.



Concrete Runways at Fort

Aviation as a New Factor in Transportation

A Survey for the Civil Engineer of Our Amazing Progress, Touching Not Only Airports and Airways but the Related Motive Power Problems of Fuselage and Motor Design

By W. G. Herron
Vice-President, Boeing Air Transport

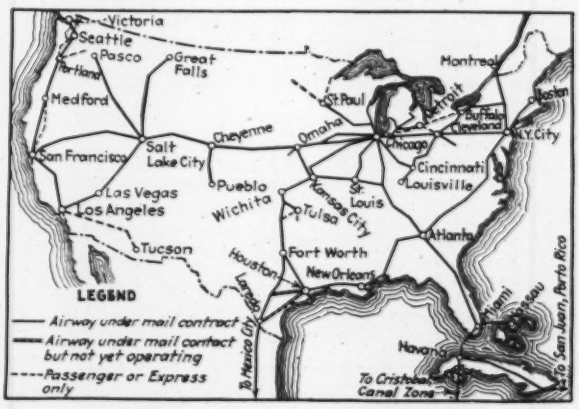
Mr. Herron, in addition to his connection with the Boeing Air Transport, is secretary-treasurer of the American Air Transport Association (an affiliation of practically all air mail, passenger and express operators in the United States), is a member of the board of directors of the National Aeronautical Association for Illinois and has served on many aeronautical committees. Together with the recently acquired routes of the Pacific Air Transport, the Boeing company carries about one-third of all United States air mail and in addition operates at Seattle the largest airplane factory in the United States if not in the world. In its air-transport operations the company employs 40 pilots with about four men on the ground for each pilot. —Editor.

TRAVEL by air has been brought to a state in which it is the commonly accepted means of transport for passengers, mail and express wherever there is a premium on speed. Furthermore, its dependability and economy are daily securing wider recognition. Our air transport industry has attained major proportions and instead of lagging behind Europe, we now are taking the lead in many branches of aviation and there is every indication that the near future will see still further advances. In Europe, for example, there is almost no night flying on regular schedules, and representatives of European countries over here to study our airway lighting systems are astonished to find that more than one-half the mileage of our transcontinental mail flights is covered in the dark.

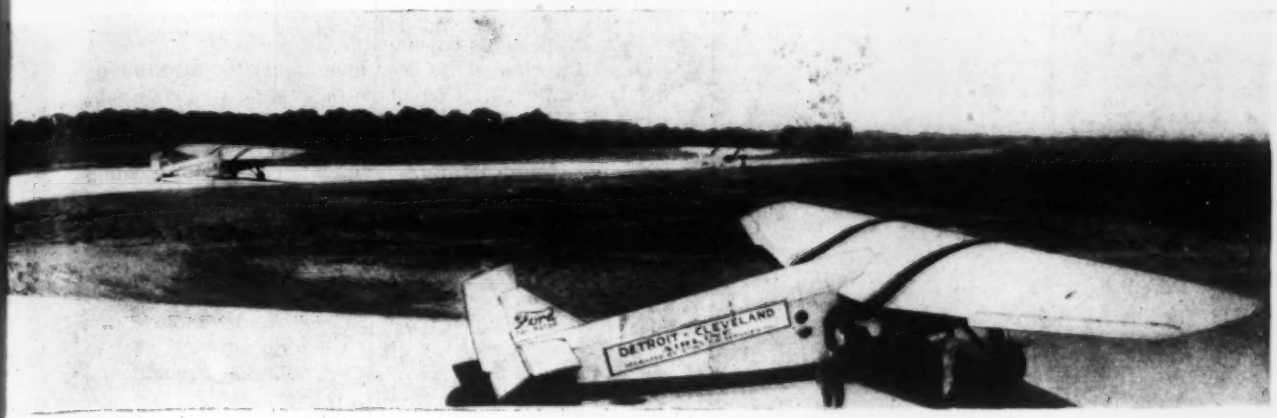
The story of the past year's progress in concisely told in figures of the American Air Transport Association, which lists 4,000 airplanes built in the United States during 1928, an increase of about 100 per cent over the year before, while 28 manufacturers are preparing to build 10,000 planes in 1929. The tonnage of air mail, which almost doubled when the postage rate was reduced, increased about 125 per cent during the year, and the total for the year was 1,700 tons. The association's estimate on total miles flown last year is 60,000,000, of which only one-third consisted of army and navy flights. The number of planes now in service in the United States is about 25,000, and the expenditure for planes, airports and the transportation of mail and passengers over established routes has reached the remarkable annual total of $100,000,000.

The Pacific Coast has enjoyed a relatively larger share in aviation activity than other parts of the country because of the high percentage of good flying weather, the widely separated cities and the mountainous and arid country which is crossed with difficulty by other means of transportation. It is notable that at the end of 1928 there were concentrated on the west coast between one-quarter and one-third of all the pilots and airplanes listed for the entire United States.

The recent 25th anniversary of the first flight of a heavier-than-air machine drew attention to the fact that during this quarter-century a network of airways totaling 20,326 miles has been developed as compared with the 9,021 miles of trackage that existed on the 25th anniversary of the railroad. The 25 years divide naturally



MAP OF UNITED STATES AIRWAYS



Airport, Dearborn, Mich.

into three periods of development: (1) experimental, 1903-16; (2) military, 1917-18; and (3) commercial, 1919 to date. In the nineteen months of American participation in the World War the number of military planes owned by the government increased from 300 to 11,800 and air service personnel leaped from 1,383 to 222,008. After the war this country was slow to develop commercial aviation. European countries did so extensively, but the public was not "airminded" and equipment was poor, with the result that the operators were able to continue in business only with the aid of generous government subvention.

In this country, fortunately, subvention was not favored, and though development was slower it was more

MILES FLOWN IN SCHEDULED SERVICE OVER TWELVE-MONTH PERIOD (A.S.M.E.)

	1924	1925	1926	1927
Great Britain	890,000	865,000	840,000	873,000
Netherlands	482,800	679,753	597,500	813,510
France	2,249,000	2,946,000	3,243,900	3,755,369
Germany	1,860,000	3,070,000	3,816,144	5,921,593
United States	2,220,761	2,910,611	4,407,263	6,009,226

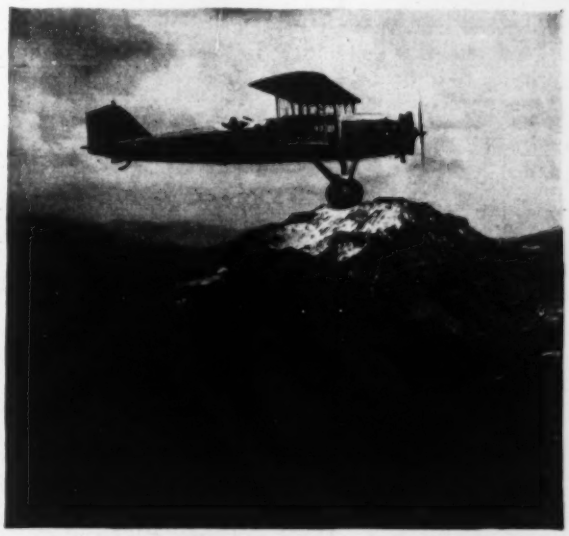
substantial. The Postoffice Department began air-mail flights in May, 1918; in 1924 night flying on a through transcontinental air route was begun and during 1926 and 1927, with air-mail service well established, all air-mail transport was turned over to contract carriers.

Replacing Government Service—The Boeing Air Transport took over the air-mail route from San Francisco to Chicago in July, 1927, and between that date and Dec. 1, 1928, operated on this route 2,240,000 plane-miles, 46 per cent of this total distance being flown in darkness. During that period, records of the Boeing Air Transport and the Pacific Air Transport, which were recently consolidated, show totals of 2,111,000 passenger-miles and 1,245,000 lb. of air mail carried, the latter figure being about one-third the air-mail total for the United States.

The longest route thus far established in the United States under one control is from San Francisco to Chicago, 1,943 miles, which is operated in five divisions, with planes going each way every day in the year. A staff of 28 pilots, including relief men, fly the planes on this run, and so far as practicable each pilot is kept on the same division. The pilots who fly between San Francisco and Reno, Nev., make the trip through 8,000-ft. passes in a mountain range with 12,000-ft. peaks as regular daily routine winter and summer. The senior pilot on this run has crossed the mountains 1,700 times with only one forced landing and that made without damage to plane or contents.

Federal Regulation—All interstate commercial aviation is subject to the regulatory control of the aeronautics branch of the Department of Commerce, which is now well organized with staff and facilities adequately to protect the public. This is done by creating a combination of four elements, the department points out, which are essential to safety in air transport—namely, (1) airworthy aircraft adequately equipped, efficiently maintained and (2) flown by competent pilots over (3) suitably equipped airways (4) in conformity with standard air-traffic rules. This supervision has been effective. Reports of the department show that 97¾ per cent of licensed planes flew last year without a single fatality. In handling the air-mail the mileage was 1,414,000 for each fatality.

Most states are considering legislation that will afford the needed regulatory control on intrastate traffic. However, applications for federal license have been filed by about 80 per cent of all aircraft, both for interstate and for intrastate traffic. This has been the natural result of public education to the point where the protection that such licensing affords is demanded.



AIR-MAIL PLANE IN FLIGHT OVER "SECRET PASS," NEVADA

Planes of this type fly the transcontinental route daily throughout the year.

COCKPIT OF PASSENGER TRANSPORT WITH DUAL CONTROLS

Central lever operates brakes on wheels used in landing and turning. Brakes may be applied together or independently.

Regulatory control of this sort entails the licensing and inspection of pilots, mechanicians, planes and motors. The great rapidity with which the industry has expanded has called for unprecedented expansion of the department—for example, more than 400 flying schools are now operating and applications for pilots' licenses are being filed at the rate of about 2,500 per month. The department is taking care of these increases but under tremendous pressure on account of insufficient funds and the resulting lack of personnel.

Research and Subvention—During the past year the national advisory committee for aeronautics has done much to co-ordinate scientific research carried on by various agencies and has itself contributed data of great value—for example, in studies on combating ice formations and on motor cowlings to cut down air resistance. Research work also has been done under the direction of the Department of Commerce on a wide range of subjects, including (1) directive radio beacons as aids to navigation; (2) improved airway lighting equipment, including fog-penetration studies; (3) soundproofing airplane cabins; (4) airplane control tests; (5) welding joints in tubular members for aircraft, particularly with chrome-molybdenum steel, and (6) testing of commercial aircraft engines. Work under this last-named head has become increasingly heavy of late with the appearance on the market of many new aviation motors.

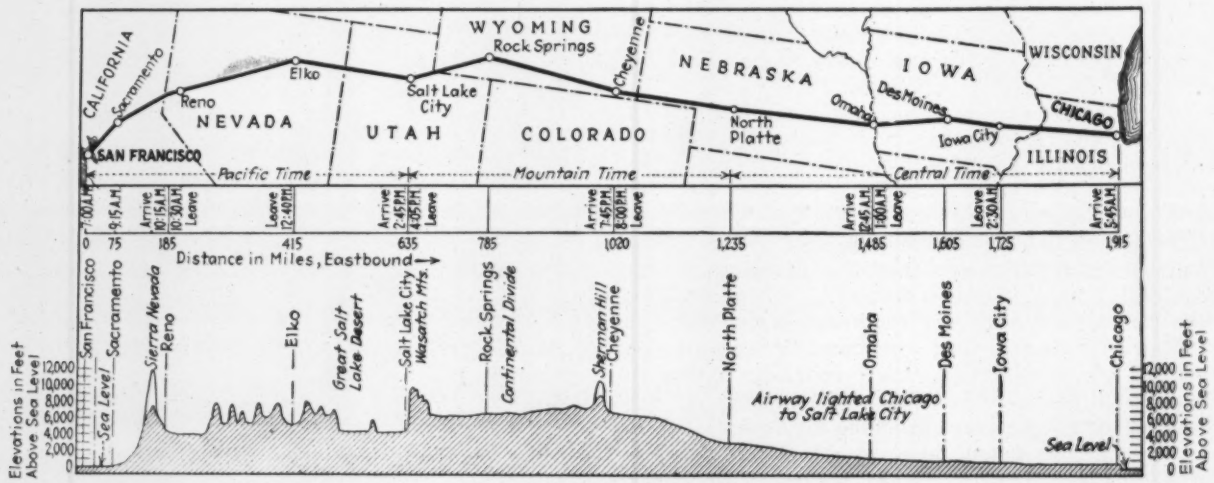
As an instance of the great value of research work in such a new industry, it may be said that certain tests in the Langley field propeller research tunnel last year led to improvements in propeller design which made it possible to increase the maximum speed of a plane from 118 to 157 m.p.h., which is the equivalent of adding 83 hp. to a motor rated at 225 hp. without additional engine weight or cost, fuel consumption or weight of structure.

Airports—The modern airport must be much more than the fairly level area freed of rocks and obstructions that formerly sufficed. The weight of the modern air liner may be as much as 6 to 8 tons, and to move this load over the ground safely at normal landing and take-off speeds calls for careful treatment of the ground surface. Airport requirements include well-drained, hard-surface runways, landing strips, beacons, high-power landing lights, floodlighting, adequate communication facilities, meteorological stations and, in fact, the well-equipped airport has need for most of the requirements that are essential to a small modern city.

Adequately to anticipate airport needs as a whole calls

TYPICAL AIRPORT INVESTMENTS
(Including Land Value or Purchase Price of Land)
(Department of Commerce Figures)

St. Paul, Minn.	$550,000
Oakland, Calif.	1,500,800
San Francisco, Calif.	1,000,000
Chicago, Ill.	1,850,000
St. Louis, Mo.	2,000,000
St. Joseph, Mo.	200,000
Buffalo, N. Y.	650,000
Cleveland, Ohio	1,220,000
Philadelphia, Pa.	160,000
Boston, Mass.	1,075,000
Fort Worth, Tex.	175,000
Hartford, Conn.	155,000



PLAN AND PROFILE OF CHICAGO-SAN FRANCISCO AIR ROUTE
This route is flown in 22½ hours as against train time of 63 hours.

for a high degree of engineering skill. Because airport development has become costly, the larger projects are being undertaken chiefly by municipalities. Only a city or a large private corporation can afford the development of an airport that the Department of Commerce would rate A1A. [These three classifications being the highest ratings in (A) housing facilities and equipment, (1) runways and landing strips, and (A) lighting equipment for night landings.]

On drainage and grading problems the civil engineer needs no help from the aviation fraternity, but on flying field surfacing it may be to his advantage to study the fliers' needs. Take-off runways that have hard surfaces (preferably pavements) enable planes more quickly to attain flying speed and, in effect, shorten the necessary length of the field. A class 1 runway, required to be 100 ft. wide, has service requirements somewhat less than those of ordinary highway. Either concrete or asphalt may be used and fairly satisfactory earth runways can be maintained where soil composition is favorable, provided dragging and rolling are done occasionally.

For landing strips, on the contrary, fliers prefer a surface soft enough to develop drag resistance that slows down the plane more quickly. In bumpy landings there is less rebound from a relatively soft surface than from a rigid pavement. Turf is used extensively in small airports, but an untreated earth surface where traffic is heavy will develop mud ruts in winter and dust from the propeller back-wash in summer. The dust is particularly harmful to motors and offensive to patrons. Treatment of landing strips to control the dust nuisance, as suggested by the Standard Oil Company, calls for scarifying the surface to a depth of about 3 in. and putting on road oil of 60 to 70 per cent asphalt content, in two applications of ½ gal. per square yard each.

Airport facilities will doubtless improve steadily, with correspondingly increased demands on the civil engineer. For example, instead of service trucks for fueling, underground gasoline pipes have become the preferred method. Gasoline is stored in underground tanks off the flying field and is pumped through underground pipes to meter dispensers in steel boxes set at convenient points in the field with their tops flush with ground level. These boxes contain 75 ft. of gasoline hose, air and water hose, and, for night service, an electric light on an extension cord.

INTERIOR OF A MODERN AIR LINER
A lavatory at the rear is equipped with patent toilet and has hot and cold running water.

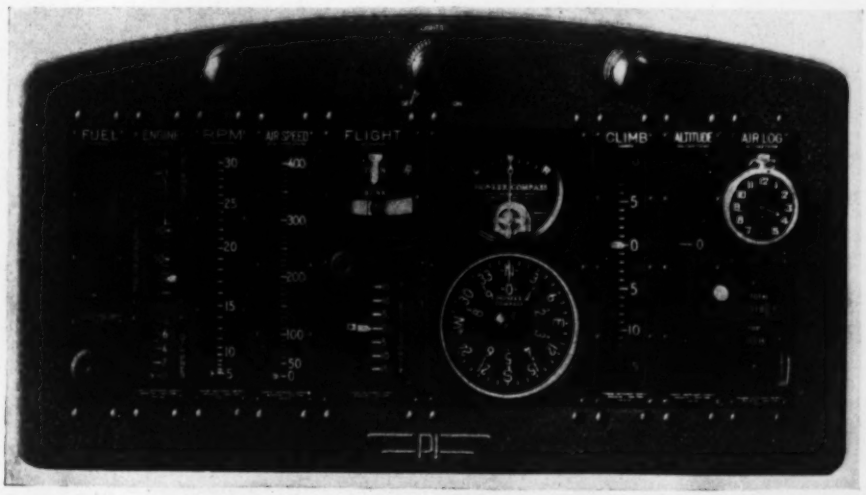
Floodlights for night landings ordinarily consist of two 10,000-watt lamps, each backed with a 24-in. mirror and mounted behind a lens of special construction. The two lamps together give a beam spread of more than 80 deg. with an upward stray-light cut-off for all rays exceeding 5 deg. above the horizontal. The floodlights have a movable vertical strip of opaque material in front of the lens which is manipulated by the operator so that an incoming plane is kept in the shadow, thus preventing glare in the eyes of the pilot. Boundary lights, floodlighting for all buildings and illuminated wind cone are necessary parts of the lighting equipment.

As an indication of what may be expected in the development of terminal facilities, five airports in and near Los Angeles represent a total investment of about $10,000,000. This by no means exhausts the opportunity for such developments, for there are in the Los Angeles metropolitan area approximately twenty other landing fields of varying sizes. Figures for the entire United States list 1,600 airports and about 4,000 fields designated as suitable for airplane landings. Government reports show an average of 75 airports per month built during the last fiscal year.

Airways—The establishment of adequate airways has been an urgent need second only to the need for airports. Location of the best routes has been a matter of topography and meteorology; with the route established, intermediate landing fields are located at approximately 30-mile intervals; then comes the lighting of both route and fields for night flying, and finally the establishment of an adequate weather reporting service.

On July 1 last 5,880 miles of lighted airways was in operation and work was under way on 1,800 miles more, with another 5,308 miles to be lighted during 1929. Thus by the close of this year there will be about 13,000 miles of airways in this country lighted for night flying.

The lighting beacons are of the rotating type similar to those used by the lighthouse



INSTRUMENT BOARD FOR CROSS-COUNTRY PLANE
Vertical type instruments are very compact. Motor information grouped at left, operation and navigation at right.

service and are mounted on steel towers, 51 to 87 ft. high. The lamp itself is usually of 900-watt capacity backed by 24-in. silvered mirrors that concentrate the light in a narrow beam of 8,000,000 cp. Each beacon is provided with an automatic lamp changer, so that in case the bulb burns out a new one is substituted within a fraction of a second.

The cost of lighting the intermediate landing fields, not including beacons, has averaged about $5,000. The location of these fields is selected by the staff of airway engineers maintained by the Department of Commerce, and for each field an attendant or at least a caretaker is employed to give regular attendance. This attendance is supplementary to the maintenance and inspection of the mechanical equipment which is provided at regular intervals by a skilled mechanic assigned to patrol each section of the airways. Ordinarily sections are about 175 miles long.

The airway network, lighted and unlighted, represents the backbone of commercial aviation. At the beginning of 1929 it was estimated that various air transport companies had in operation, over established airways, scheduled routes totaling 16,000 miles with a daily total flying schedule of 40,000 miles. However, Department of Commerce figures indicate that the total amount of flying over airways constitutes only one-tenth of all civil flying and estimates the non-scheduled flying in the last fiscal year at 30,000,000 miles as a minimum.

Typical of the aid that can be rendered by a weather service, 35 weather reporting stations have been established along the airways between San Francisco and points south. Observers at these stations report every 1½ hours to four main stations which are interconnected with telegraphic ticker tape equipment. With this arrangement ticker tape records are made simultaneously at important centers every 1½ hours, thus affording a weather reporting service which is, when interpreted and recorded by the meteorological experts who are stationed at the various airports, of great value to fliers.

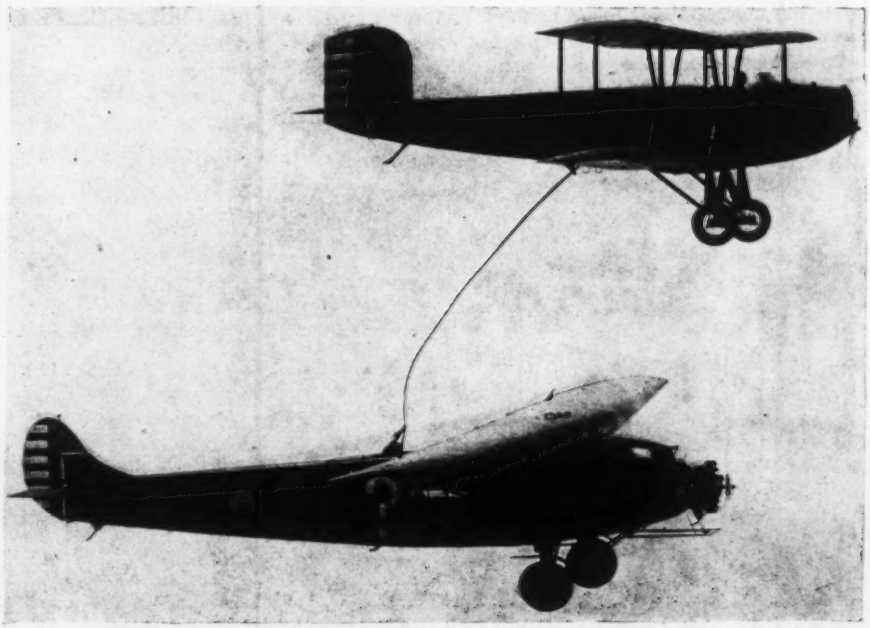
Airplane Types and Design—The incentive to making records has lured the airplane designer into specialization. Specially constructed planes now exist with *(a)* a flying range exceeding 4,000 miles; *(b)* a speed of 278 m.p.h.; *(c)* a ceiling exceeding 38,000 ft.; *(d)* the ability to climb 30,000 ft. in 30 minutes, and *(e)* pay-load capacities of several tons. Still other designs have been aimed toward developing a maximum strength and stability for navigation under adverse weather conditions.

Where endeavor is made to approach the limit in any of these special services more or less of a compromise has to be made in other lines. However, progress in all directions has been such that reasonable requirements of all ordinary service can be met with a wide margin of safety. In fact, in terms of speed, altitude, etc., the records have been pushed so far that in any further advance human endurance promises to be as much of a problem as elements of special design. For example, there are now many planes well able to withstand the strain of an outside loop, but the strains on the pilot are so great that both army and navy have forbidden this maneuver.

Whatever the type or design, the Department of Commerce has set up the requirement that to be eligible for license an airplane structure must be able to withstand stresses seven times those imposed on the various members in normal flight. While this figure is arbitrary, it is based on the stresses sustained by a plane in violent maneuvers. The safety factor involved is slightly less for small craft with great maneuverability and slightly more for large ships whose movements are slower.

In terms of loading per unit of horsepower the size of the ship makes little difference; small ships are as economical as large ones. This is because power and fuel requirements increase rapidly with size increases. Size increases by no means bring corresponding pay-load capacity increases; if the same geometrical form is maintained as size is increased, the wing area increases as the square of some dimension, say the wing span, whereas the net weight of the ship increases approximately as the cube of the span. Federal regulations limit the load to be lifted to 14 lb. per square foot of wing surface.

There seems to be an economic limit of somewhere near 25 lb. gross load per horsepower below which practicable designs have not appeared. This holds regardless of the type. The weight per horsepower, gross, of the plane in which Lindbergh crossed the Atlantic was 23.6 lb., Chamberlain's plane, 24.5 lb., and Byrd's plane, 27.5 lb., the latter despite the fact that this plane was three times as large and had three times the power of the others. It is interesting to note that the modern ocean liner requires more horsepower per passenger than does the airplane.



PLANE TAKING ON FUEL WHILE IN FLIGHT
The "Question Mark" flew continuously for more than six days with more than 30 contacts for taking on supplies.

The engineer will appreciate the economics that govern the selection of single- or tri-motored planes for a stated service. Operating costs on tri-motored planes will be at least three times that of the single-motored plane while giving something less than twice the pay-load capacity.

The reliability of motors is now the point on which attention must be centered in raising the average of dependability. This is well illustrated by government figures showing only 5 per cent of accidents for 1927 due to structural failures (and these few included those resulting from old war-time equipment). This viewpoint is further supported by the recent experience of the army plane "Question Mark," which came down after 150 hours in the air only when the motors began to fail. Generally speaking, for de luxe passenger service of the future, tri-motored planes will be used, but single-motored planes will be preferred for carrying mail and express. Both monoplanes and biplanes are used by air transport operators. An adequate discussion of the relative merits of these two types would exceed the space available in this article.

With increasing production leading to new processes, metal fuselage construction has become almost universal. The advantages are greater rigidity, less tendency to sag, simpler maintenance and less weight. For the fuselage structure special tube steels have been used extensively. Recently there has been a steadily increasing use of duralumin, an aluminum alloy containing copper, manganese and magnesium with strength and toughness comparable with those of mild steel and a specific gravity of 2.81 as against 7.80 for steel. It is a highly ductile metal, capable of heat treatment, and when heat treated and hard rolled is rated for ultimate tensile strength between 67,000 and 72,000 lb. per sq.in. with a yield point of 55,000 to 65,000 lb. per sq.in. Besides being in demand for tubing, this metal is sometimes used in thin sheet form in place of linen for covering wings and fuselage, thus giving an all-metal type of construction.

Notable among the year's advances in air transport has been the appearance in regular service of tri-motored planes of large capacity with accommodations for as many as fourteen passengers; several twenty-passenger planes are under construction. Equipment of this sort for travel during the day with stated connections for transfer to Pullman-car sleepers for travel by night also has been planned by some operators for those who prefer this means of transcontinental travel.

Aviation Motors—A large percentage of motors used in commercial aviation in recent years has come from the surplus stock of war-time, water-cooled motors. This stock is now practically exhausted and superior new-production motors are coming into general use. At present more than 50 aircraft motors below 300 hp. are in various stages of development, according to a report of the American Society of Mechanical Engineers. The modern radial air-cooled motor ordinarily weighs 2 lb. per horsepower and aviation motors seldom exceed 4 lb. per horsepower. The special requirements that aviation imposes will be appreciated when it is remembered that the average automobile engine weighs 10 to 15 lb. per horsepower.

Engine construction lightened to this extent has been a factor in making the life of airplane motors comparatively short. Although greatly extended as compared with the early days of aviation, good practice now allows only 150 to 300 hours between overhauls and usually not more than 1,000 hours of flying in commercial service before complete overhaul and perhaps replacement.

Motors on regular schedule service where they must withstand the strain of rapid temperature changes and sometimes overloading require overhauls at shorter intervals than motors used in pleasure service only, where the motor is rarely subjected to severe operating conditions.

As a general indication of fuel consumption, tests made by the Standard Oil Company show the rough averages given in the following table:

Manufacturer	Type	Hp.	Gasoline Per Hr. (Gal.)
Curtis	OX5	90	7
Wright	Whirlwind (J-5)	220	11
Pratt & Whitney	Wasp	420	18 to 24
Pratt & Whitney	Hornet	525	22 to 30

Motor power, of course, is measured in terms of torque and speed. In the automobile engine the power is increased by running the speed up to 3,000 or 4,000 r.p.m. For aviation service, however, the additional weight and complication of equipment involved in gearing the motor to the propeller has until recently discouraged development in that direction. Mounting the propeller directly on the main shaft, which is the almost universal practice, requires a motor speed within the range of efficient propeller speed, which is between 1,500 and 2,000 r.p.m. That is, this is the maximum speed at which the air-screw can be operated efficiently; beyond this point power is reduced by cavitation and excessive slip. Hence another controlling limitation in aviation motor design.

Such limitations in design, the opportunities afforded by a new industry and the incentive of rapid advance make aviation a constant challenge to the engineer. This is not only an opportunity but also an obligation, for in this period of development aviation is looking to the engineering profession as mentor and guide.

NEW HANGARS AT OAKLAND, CALIF., HAVE 120- INSTEAD OF 90-FT. OPENINGS TO ADMIT MODERN PLANES

Status of MAJOR ENGINEERING PROJECTS

Brief Statements of the Progress Made to Date on the More Important Civil Engineering Developments in the United States and Canada Which Are Either Under Construction or to Be Started During the Current Year

Hetch Hetchy Water Project

San Francisco has just begun the final stage in closing the gap in the aqueduct that is to bring a mountain water supply to the city. The approval in 1928 of bond issues totaling $65,000,000 provided sufficient funds for finishing the 168-mile aqueduct, as well as for purchasing the distribution system of the Spring Valley Water Company. Construction progress during the year included the holing through of the last of the 16.7-mile Foothill division tunnels and getting well under way the concrete lining required for 45 per cent of this total length. There remains to be constructed 29 miles of tunnel through the Coast Range and 45 miles of steel pipe line across the San Joaquin Valley, the latter to connect Coast Range and Foothill tunnels. Now that funds are available, the tunnel work will be advanced from fourteen headings; later the valley pipe-line construction will be started at the proper time to bring these two sections to a co-ordinated completion. It is now expected that Hetch Hetchy water will be delivered in San Francisco in 1932.

Southern Pacific Suisun Bay Bridge

A double-track railroad bridge 6,000 ft. long across upper Suisun Bay near Benicia, Calif., to eliminate the train ferry on the main line of the Southern Pacific was approved by the War Department Oct. 15; detailed plans were begun at once and bids for construction of the piers are to be received this month. Piers for the ten main spans are to be built in 40x60-ft. open caissons sunk by internal dredging to rock foundation, the depth of the rock reaching a maximum of 140 ft. below low water. The main spans are to be about 530 ft. long and 70 ft. in the clear above high water. There will be one lift span which will give a clearance of 135 ft. The estimated cost is $12,000,000 and the time for construction about two years.

Mokelumne Water Supply

The East Bay Municipal Utility District, now serving nine cities on the east side of San Francisco Bay with water from local sources delivered through the recently purchased system of the East Bay Water Company, made rapid progress on the Mokelumne project during the past year. At Pardee dam, which provides the main storage for the new source of supply, concrete pouring is nearing completion at a rate such that the 600,000-cu.yd. job will be finished a year in advance of contract time. Pouring was 70 per cent done on Jan. 1. Excavation of the 2.2-mile outlet tunnel from this reservoir has been completed and concrete lining is well started. The 95-mile aqueduct, consisting chiefly of 65-in. longitudinally welded steel pipe, has been finished.

San Gabriel Dam

Contract has been awarded and preliminary work is under way on the record-breaking San Gabriel dam for the Los Angeles County Flood-Control District. Located on the San Gabriel River about 30 miles east of Los Angeles, this structure, of arched gravity type, 430 ft. above streambed and almost 500 ft. above the deepest rock excavation, will have a capacity of 240,000 acre-ft. to be used for flood protection and water conservation. Flood protection is to be assured by reserving about 85,000 acre-ft. of the capacity for this purpose. A mass of almost 4,000,000 cu.yd. of concrete presents opportunity for new construction methods and progress records. A railroad to the site already built by the district is to be operated by the contractor. The contract calls for the completion of the dam in six years.

Oakland Estuary Tunnel

A vehicular tunnel, 4,436 ft. long, built by trench method for street traffic under the estuary between Oakland and Alameda, Calif. The tunnel was opened to traffic on Oct. 27, 1928.

Diablo Dam for Seattle Power

The Diablo dam, for the city of Seattle hydro-electric development on the Skagit River, was about 25 per cent completed Jan. 1, sixteen months after the contract was let. Nearly 400 ft. high, this constant angle arch dam will contain 300,000 cu.yd. of concrete and store 90,000 acre-ft. for immediate use in the present Gorge plant, about 6 miles below the dam. A proposed second plant at the dam site will later also utilize this storage. Concrete in the river channel is more than 60 ft. high. Completion of the dam is expected in about a year.

Cascade Railway Tunnel

This great rock tunnel, 7.8 miles long, the principal feature of a line revision project by which the Great Northern Railway secures a lower and more favorable summit crossing of the Cascade Range, was completed near the end of 1928. Remarkable speed was made, in spite of water and bad ground, the construction being completed in three years. The contract was let Nov. 27, 1925. The pioneer tunnel, extending 5½ miles from the west end to a shaft, was holed through on May 1, 1928. The main or railroad tunnel, driven from numerous headings, was holed through on Dec. 8, and the concrete lining, which had followed closely upon the enlargement of the headings, was completed Dec. 24. After the completion of the tunnel there remained the ballasting and tracklaying, which was finished on Jan. 6, 1929, the first train being run on Jan. 12. Tunneling records were broken on this work, and the maximum progress on the pioneer tunnel, 8x9 ft. in section, was 52 ft. for one day and 1,157 ft. for one month.

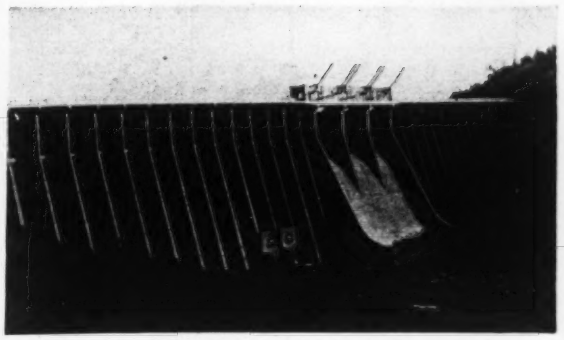
U. S. Reclamation Dams

The Owyhee reclamation project for the irrigation of 124,000 acres in Oregon and Idaho is to have a dam 360 ft. high in the canyon section of the Owyhee River 20 miles from its mouth. A spur railroad line to the site taking off from a point near Adrian, Ore., 22 miles away, was completed last November at a contract price of $345,301. An upper diversion dam has been built to protect excavation work and the enlargement of the spillway and diversion tunnel is finished. Excavation of keyways is under way.

Gibson dam, Montana, to furnish a supplemental supply for 90,000 acres of the Sun River project, is 90 per cent completed. It is of massive concrete-arch type, 179 ft. high, costing $345,301.

Final work on Stony Gorge dam to form a reservoir for a supplemental supply to 20,000 acres now under cultivation in the Orland project in California was done last October. The dam is 120 ft. high, of buttressed type with a reinforced-concrete slab, and was contracted for at $518,904.

Echo dam, to furnish storage for the Salt Lake basin irri-



STONY GORGE DAM, CALIFORNIA

gation project, is to be of clay, sand and gravel sprinkled and rolled and is now 35 per cent completed. It will be 125 ft. high, 1,800 ft. long and 1,700,000 cu.yd. in fill at a contract price of $1,125,098.

Deadwood dam, in Idaho, will be put under construction early in the spring, it is hoped. The project has been approved by the President, but is held up pending the settlement of mining claims on the reservoir site. The dam will be a concrete arch 160 ft. high forming a reservoir of 150,000 acre-ft. capacity for the Payette division of the Boise irrigation project.

Construction of the Kittitas division of the Yakima project in Washington is well under way. Existing contracts cover 26 miles of the North Branch Canal with canal lining and structures. Work is also in progress on Easton dam, a small diversion structure, with ¼ mile of main canal. A total of $9,000,000 will be spent for the construction of the dam and canal system to irrigate 70,000 acres.

On the Vale project, in Oregon, the first division of the main canal about 9 miles in length is finished and work is under way on an additional 9 miles as well as a diversion dam across Malheur River and tunnels for the main canal.

Coolidge Multiple-Dome Dam

Closure of the Coolidge multiple-dome dam on the Gila River in Arizona was effected Nov. 15 and storage was begun about nine months ahead of schedule. Being the first large multiple-dome dam ever constructed, the novel design offered new and unique problems in form work. However, construction problems were speedily solved and it is reported that no cracks or other defects have developed. This dam was built by the U. S. Indian Service and will store 1,200,000 acre-ft. of water to be used for irrigating land adjoining the Salt River irrigation project.

St. Louis Water-Works Extension

The new water supply for St. Louis, Mo., to be taken from the Missouri River to supplement the existing supply from the Mississippi River, has been completed in most of its parts, and all of the rest are well along. It is hoped that the entire new plant will be in operation early in March, 1929. Completed portions include the intake and 87,000 ft. of 60-in. riveted steel pipe leading to the 100-m.g. Stacy Park covered reservoir, already completed. The filtration plant and accessories are well along, as also the pump and boiler houses. The turbine centrifugal pumps are installed and ready for operation. These include a 100-m.g.d. and two 50-m.g.d. low-service pumps, and two 60-m.g.d. high-service pumps.

Illinois Waterway

A waterway of 63 miles, from the Chicago drainage canal at Lockport, Ill., to the Illinois River at Starved Rock, is being built by the State of Illinois as a part of the proposed barge waterway connecting Lake Michigan with the Mississippi River. Its channel is 200 ft. wide, with 9-ft. depth of water and with five locks 110x600 ft., the first having the unusual lift of 41 ft. The $20,000,000 provided by bond issue is nearly all expended and the work is still far from completion. It has been proposed to have the federal government take over the work or provide funds, but no action has been taken.

Detroit Bridge

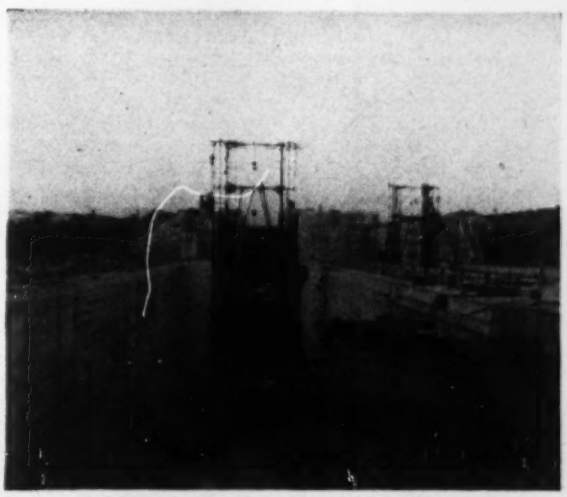
The suspension bridge across the Detroit River between Detroit and Winsor, Ont., was placed under construction in the summer of 1927. During the past year pier and anchorage construction has been completed, the main towers have been erected and the cable spinning has been finished. Work is now progressing on the approach steel work and on preparations for main span floor and stiffening truss erection. The structure has a main span of 1,850 ft. and carries a single highway deck.

Detroit River Tunnels

Twin vehicular tunnels under the Detroit River between Detroit, Mich., and Windsor, Ont., similar in cross-section to the Holland tunnel at New York except that the outside diameter is to be 30 ft. and the roadway 22 ft. The river portion is to be of steel and concrete, in ten 248-ft. sections, partly built up on land, floated to the site and sunk in a trench on the river bottom. One of these sections has been launched and two are under construction. The portions of the tunnel flanking the river portion are to be shield-driven. One land shaft for this work has been sunk and is ready for the shield.

Welland Ship Canal

Construction operations on the Welland Ship Canal made good progress during 1928, all sections from Lake Ontario to Lake Erie being under construction, with the northerly end of the work from Lake Ontario to Thorold approaching completion. At Port Weller a contract was let for the construction of the gate repair yard and basin. It will be ready for operation at the end of 1929. During the year a contract was let for all operating machinery and valves, delivery to be completed in 1929. Locks 1, 2 and 3 were entirely completed except for operating machinery at locks 2 and 3. Work on the other locks and their gates is approaching completion. The greater part of the canal prism is completed except for the sections where the present canal crosses the new canal. Part of this excavation will be carried on during this winter and the remainder will be carried on during the winter of 1929-30. The new siphon culvert to carry Chippewa Creek under the ship canal was completed during the year except for the discharge channel, and canal traffic diverted across it in December. The discharge channel will be completed this winter and subsequently the present aqueduct will be removed. The harbor dredging at Port Colborne will be completed by the end of the 1929 construction season. Most of the bridges are completed or well along



FLIGHT LOCKS, WELLAND CANAL

toward completion, the contract for the last three being let in 1928. All will be completed by 1930. It is expected that the canal will be ready for operation in 1930. To date approximately $100,000,000 of the total estimated cost of $115,000,000 has been spent.

Sanitary District of Chicago

The North Side sewage-treatment works, the largest activated-sludge plant in the world, was placed in permanent operation Oct. 3, 1928. It will provide for a population of 830,000 people, of whom about 360,000 are now actually being served. The remaining population will become tributary before the close of the year with the completion of the North Branch pumping station and the opening of the remaining sewer connections. The total cost of the treatment works proper will approximate $18,000,000 and of the interceptors and the North Branch pumping station $13,500,000. At the West Side sewage-treatment works one of the three batteries of Imhoff tanks, together with the main pumping station and structures for preliminary treatment, are substantially completed and will be placed in operation early in the year. A second battery of tanks and the necessary sludge-drying beds are under contract and will be completed and in operation before the end of the year. This plant will serve a population of 1,850,000 besides providing for digestion and disposal of the waste sludge from the North Side works. The estimated cost of the treatment plant is about $29,000,000 and of the interceptors $25,000,000. Since the granting of the permit by the Secretary of War on March 3, 1925, for diversion of water from Lake Michigan, construction work to the value of $47,500,000 has been done on sewage-treatment projects. The value of the construction work done to date on the sewage-treatment program by the Sanitary District of Chicago has been about $78,500,000.

Cleveland Passenger Terminal

Rapid progress was made during the year on the new union terminal which is being built in Cleveland for the Nickel Plate, New York Central and Big Four railways. The approach viaduct over the Cuyahoga River valley is well along toward completion and the terminal structures are well advanced. The 52-story tower building, the central feature of the terminal, was completed during the year.

Alabama State Docks

An ocean terminal at Mobile, constructed by the State of Alabama. One pier and all the railroad yards were in operation at the opening of the year 1928. The remainder of the project was completed during the latter part of the year.

Ohio River Locks and Dams

Improving the Ohio River for navigation by providing a minimum channel depth of 9 ft. for its entire length of 968 miles continued throughout the year by the Corps of Engineers. The work consists of construction of fixed and movable dams with navigation locks having general net dimensions of 110x600 ft. at each dam. Navigable passes vary in width from 600 to 1,248 ft. and are closed by wickets of the Chanoine type. All of the dams except numbers 51 and 53 are completed and it is expected that the whole project will be finished next summer. Total cost of the work is estimated at $105,000,000.

WATERFRONT DEVELOPMENT, CHARLESTON, S. C.

Saluda Dam

Hydraulic sluicing has been started on the great earthfill dam on the Saluda River 10 miles west of Columbia, S. C., being built by the Lexington Water Power Company. Fill is being placed in the outside slopes by dump cars from trestles and an impervious center core is being sluiced into place. Four 16-ft. diameter concrete penstocks and one 24-ft. diameter arch conduits are now diverting the waters of the river through the dam. Four penstock control towers 220 ft. high have been completed. When finished the dam will contain more than 11,000,000 cu.yd. of fill and will create a reservoir of 100 billion cu.ft. capacity. The maximum toe to toe width will be 1,150 ft. and the crest length will be nearly 8,000 ft. The project is expected to be completed by Sept. 1, 1930, and will cost approximately $22,000,000.

Cooper River Bridge

A toll bridge project approximately 14,000 ft. long is under construction at Charleston, S. C., across Cooper River. The project consists of steel trestle approaches at both ends, a cantilever truss with a 640-ft. span over Town Creek, a steel trestle across Drum Island and a 1,050-ft. cantilever truss across Cooper River. All of the river piers have been completed. Substructure work on the Charleston and Drum Island approaches has been finished and the steel erected on the Charleston approach. One shore arm of the Town Creek span has been erected and erection of the remainder of this span is under way. The Mount Pleasant approach substructure is now under construction. Erection of the main river span has not been started.

Arlington Memorial Bridge

Construction of the concrete arches of the Arlington memorial bridge across the Potomac River at Washington, D. C., is practically completed. The concrete walk and roadway decks are now being poured. Work on the granite facing has followed the construction work on the arches. The cost of this facing accounts for approximately a third of the construction cost of the bridge, which totals more than $7,000,000. A contract has been let for the construction of a 216-ft. steel bascule span, which will be covered with an ornamental iron fascia to present an appearance in keeping with the granite facing on the remainder of the structure. A contract has also been let for the construction of the boundary channel bridge at the Virginia shore line which will form the western end of the project.

Conowingo Dam and Power House

A 4,800-ft. dam and power house built near the mouth of the Susquehanna River by the Susquehanna Power Company, a subsidiary of the Philadelphia Electric Company. A total of 378,000 hp. in seven 54,000-hp. units is to be installed in the power house under the present contracts and provision is being made for four more similar units. Work was begun in May, 1926, and the first unit was brought into service March 1, 1928, three months ahead of schedule. At present all seven units are in service.

Philadelphia Subway

Two tracks of the Broad St. subway north from the City Hall to Grange Ave., about 6 miles, were put in operation Sept. 1. The new subway is being operated by the Philadelphia Rapid Transit Company under a temporary agreement with the city pending the conclusion of negotiations looking toward a permanent agreement. South of the City

Hall the present project includes about three-quarters of a mile to South St. This work is about 90 per cent complete. It is expected to have it in operation by April, 1930. Contracts have been let for ties, rails and special work for two additional tracks in the North Broad St. section. The work to date has cost about $93,000,000. Studies for further extensions of the subway system are being continued.

Pennsylvania Terminal, Philadelphia

The Pennsylvania Railroad, under an agreement made with the city of Philadelphia in 1925, is building new passenger terminal facilities at Philadelphia and West Philadelphia. The major undertaking during the past year has been the construction of the new line in Philadelphia, largely in subway, which will replace the elevated structure now running into Broad St. station.

Lake Champlain Bridge

The concrete piers have been completed for the interstate highway bridge across Lake Champlain between Crown Point, N. Y., and Chimney Point, Vt. Two of the piers extend 100 ft. below water level and were built by the use of open cofferdams and under-water placing of concrete. Erection of the steel superstructure is progressing as the weather permits. The approaches are made up of deck plate girder spans and the main spans are deck trusses, continuous over two and three spans. The center span, 434 ft. long, is a through truss, arched in form to provide an underclearance height of 92 ft. for navigation at the center. The bridge will be the only structure crossing the entire 140-mile length of Lake Champlain. It is being built by the two states and will be operated on a toll basis until paid for.

New York Water-Supply Extensions

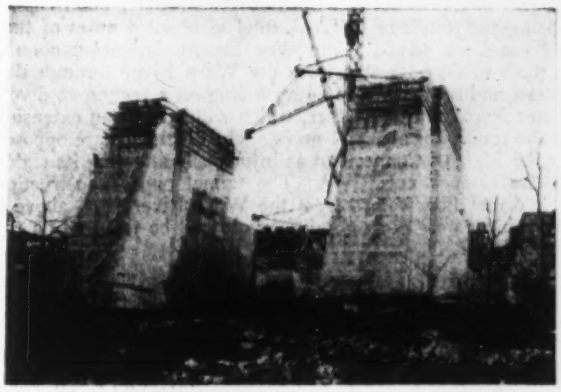
Four contracts were let by the Board of Water Supply late in October for a new pressure tunnel, 17 ft. in diameter and 20 miles long, to supplement the one already in use for delivering water from the Catskill aqueduct system to the various parts of New York City. A plan presented by the Board of Water Supply for an additional supply of 600 m.g.d. from the floodwaters of five New York tributaries of the Delaware River and 70 to 100 m.g.d. from Rondout Creek, a tributary of the Hudson, together with the diversion into the existing Catskill aqueduct system of water from some of the higher levels of the Croton system, was approved by the Board of Estimate and Apportionment in January, 1928. No appropriation was made available pending the receipt of opinions from Charles Evans Hughes and John W. Davis on the legality of the proposed plan for the diversion of the floodwaters and the compensation of the low flows. A proposal to develop 150 m.g.d. from wells on Long Island for emergency use was removed from the calendar of the Board of Estimate and Apportionment at the close of the year.

Kill van Kull Bridge

A steel arch highway bridge across the Kill van Kull between Staten Island, N. Y., and Bayonne, N. J., was begun during the year. When completed it will be the longest bridge of its type in the world, its span of 1,675 ft. exceeding by 50 ft. the new steel arch now under construction over Sydney harbor in Australia. At present work is under way on the arch abutments. The superstructure contract was awarded in November. The bridge was designed and is being built by the Port of New York Authority to be operated on a toll-refunding basis.

Fort Lee Bridge

The two steel towers of the 3,500-ft. span Hudson River suspension bridge under construction between 178th St., Manhattan, and Fort Lee, N. J., have been completed to five-sixths of their ultimate height of 600 ft. above water level. On the New Jersey side two sloping tunnels driven into the solid rock of the Palisades were completed last November



NEW YORK ANCHORAGE, FORT LEE BRIDGE

and are now receiving the steel grillage and eye-bars, which when buried in concrete, will comprise the west anchorages. The deep roadway approach cut through the Palisades is practically complete. Two concrete pillow blocks which will carry the cable splay castings and also provide anchorages for the footbridge cables and the stiffening trusses at the New Jersey end have been poured. The New York anchorage, a 107,000-cu.yd. block of concrete, is about 95 per cent complete, except for the stone facing. More than 2,200 tons of steel grillage and eye-bars are buried in this anchorage. Construction of the footbridges will begin shortly. Spinning of the four 36-in. cables will commence some time this coming summer and will take two years to complete. After the completion of the first two cables erection of the stiffening trusses and floor system will commence. The bridge is being built by the Port of New York Authority and is expected to be opened to traffic in 1932.

New York Subways

Rapid progress was made on construction of the new municipal subways at New York, and contracts amounting to about $90,000,000 were awarded during the year for construction, track, station finish, yards, etc. This included the construction for 11.35 route-miles and 38.50 track-miles of structure. On the Eighth Ave. subway construction has been largely completed from 214th St. and Broadway south to Church St. at Fulton St. and in most of this stretch, track and station finish are now under way with the prospect of operation some time in 1930.

A large portion of the Bronx line, which branches from the Eighth Ave. line at about 145th St. and extends under the Harlem River and north under the Grand Concourse, has been placed under contract. The 53rd St. tunnels under the East River have been holed through, and several contracts have been let on the Queens line, extending east along Jackson Ave., and also south along Jackson Ave. under Newtown Creek and thence under Manhattan Ave. on the crosstown line between Queens and Brooklyn. Progress has been made on the construction of the East River tunnel from Fulton St., Manhattan, to Cranberry St., Brooklyn, and on this line a large portion of the contracts has been let for the connection to the existing Culver line in South Brooklyn. One contract has been let for a section of subway in Schermerhorn St. which will connect with the subway to be built in Fulton St., Brooklyn, and with the Queens crosstown line.

On the two "dual subway" contracts on Nassau and Broad Sts., Manhattan, progress has been made, and work has been started on an extension of the Fourteenth St. line from Sixth Ave. to Eighth Ave.

Boston Metropolitan Water Project

A contract was let on April 30 for the completion of a 13½-mile tunnel from the existing Wachusett reservoir on the Nashua River in West Boylston to the Ware River in the town of Barre, to provide an additional water supply for the Boston metropolitan district. Six shafts and short

lengths of tunnel at each were excavated under contracts let during the previous year. A total of about 4 miles of tunnel has been driven. The War Department acted upon a request to divert water from the Ware River through this tunnel and application is now pending on a request to divert water from the Swift River, which will involve an extension of the tunnel for about 11 miles. The diversions are opposed by the State of Connecticut as injuriously affecting its rights in the Connecticut River. The tunnel under construction will divert floodwaters from the Ware River from above a diversion dam. A storage reservoir will be required on the Swift River.

Cobble Mountain Dam

Springfield, Mass., in the enlargement of its municipal water supply is building what will be the highest earthfill dam in the world, 245 ft., at Cobble Mountain on Little River above Westfield, Mass. The dam will be built by the hydraulic-fill method and will contain nearly 2,000,000 cu.yd. of fill. A rockfill diversion dam, 79 ft. high, which will form the upper toe of the main dam, has been completed. A 1,600-ft. diversion tunnel has been completed and is now carrying the waters of Little River around the dam site. Clearing and stripping has been completed on the main dam and actual filling operations will commence shortly. Work has been begun on the 7,000-ft. tunnel which will be the main outlet of the new reservoir and will also furnish water to a hydro-electric plant to be located on Little River just above the present water-supply reservoir.

North Station, Boston

Reconstruction of the North Station, Boston, was begun at the close of 1927. The present work, comprising the station proper and a coliseum above it, is nearly completed, the station having been put into service in December. Later an office building and hotel are to be built adjoining it.

Mount Hope Bridge

The 1,200-ft. span Mount Hope suspension bridge between Bristol and Portsmouth, R. I., is expected to be open to traffic by June 1 of this year. The structure is now practically complete except for the floor system on the main span and part of the approaches. The bridge will be operated as a private toll project.

The Construction Outlook

New Volume Record Made by 1928 Expected to Be Broken by 1929—Year's Contract Awards Totaled $9,000,000,000—Materials Supply Adequate, With Stable Prices—Labor Difficulties at Minimum—Strong Financing for 1929—Large Program Planned

EACH successive year since 1922 has made a new construction volume record. Last year carried on this tradition is likely to be beaten by 1929.

Nine Per Cent Gain Over 1927—The 1928 figure for contracts awarded is $9,000,000,000, and Fig. 1 shows the principal divisions. One-third of this is for residential construction, of which one- and two-family dwellings constitute three-fourths of the number of projects and one-third of the value.

Engineering construction in 1928 amounted to $3,550,671,000, compared with $3,254,000,000 in 1927. As the cost curve during the last two years has been almost level, this gain of 9 per cent is real. Large buildings form the principal item in both number and cost, and last year's building figures exceed those for 1927 by 36 per cent in number and 13 per cent in value.

Work Well Distributed—Geographical distribution of contracts was quite similar to that of 1927, except for a 40 per cent jump in the Middle Atlantic States. The gain of $394,000,000 in this region is due chiefly to building activity in New York, New Jersey and Pennsylvania; but $81,000,000 is due to increased public-works construction. There was a slight decline in New England and in the region between the Mississippi River and the Rocky Mountains. The Middle West and the Far West show slight gains. Construction value in the South was almost identical with the 1927 figure. Table I gives detailed figures for each class in each region for the two years.

Steel, cement and lumber all show record production. Ingot production exceeded the 1927 output by 14 per cent and structural steel sales increased 5 per cent.

Table I—Regional Distribution of Heavy Construction by Classes, 1927–1928

	New England	Middle Atlantic	South	Mid-West	West of Mississippi	Far West	Total
1928							
Water-works	$12,129	$58,127	$2,867	$9,281	$12,302	$4,731	$99,437
Sewers	1,788	21,213	5,521	44,422	11,381	16,344	100,669
Bridges	7,578	35,928	28,533	25,347	20,014	11,678	129,078
Excavation, drainage and irrigation	809	2,828	4,633	9,275	16,919	3,196	37,660
Streets and roads	24,854	146,252	81,971	157,214	137,050	65,269	612,610
Industrial buildings	38,820	95,710	68,267	74,284	49,104	27,060	353,245
Commercial, religious and institutional buildings	130,655	876,659	61,523	432,462	183,067	161,200	1,846,566
Federal government	1,769	22,870	13,174	7,838	11,765	12,465	69,881
Unclassified	3,710	123,522	21,626	24,488	95,857	33,322	302,525
Totals	$222,112	$1,383,109	$288,115	$784,611	$537,459	$335,265	$3,550,671
1927							
Water-works	$3,650	$8,283	$5,201	$14,336	$12,818	$8,901	$53,189
Sewers	2,837	25,995	4,560	55,112	14,541	14,987	118,032
Bridges	8,668	38,821	25,578	46,028	16,958	7,592	143,645
Excavation, drainage and irrigation	3,757	4,709	9,416	6,319	13,237	4,567	42,005
Streets and roads	18,226	118,015	79,069	111,928	128,160	69,671	525,096
Industrial buildings	32,329	69,262	72,021	63,229	41,407	43,067	321,315
Commercial, religious and institutional buildings	154,516	619,285	57,087	454,061	156,827	190,562	1,632,338
Federal government	3,135	15,737	8,341	4,924	6,347	12,279	50,763
Unclassified	7,156	88,887	29,192	20,018	203,122	19,035	367,410
Totals	$234,274	$988,994	$290,465	$775,955	$593,417	$370,661	$3,253,766

Cement production, shipments and stocks are larger, but only slightly larger, than in 1927, when a 5 per cent increase in output was registered. Last year 175,968,000 bbl. was produced, a gain of 2,761,000 bbl., or 1 per cent. Shipments in 1928 totaled 175,455,000 bbl. The spread between production and shipments was, therefore, only 513,000 bbl., compared with 1,342,000 in 1927. Stocks on hand at the close of 1928 amounted to 22,573,000 bbl., compared with 22,082,000 bbl. in 1927. The increase of stock is 2 per cent, the same as the increase in shipments.

Lumber producers are keen to restrict production to actual demand. On Jan. 3 the secretary of the National Lumber Manufacturers Association addressed letters to President Coolidge and President-elect Hoover, Cabinet members and members of the present and next Congress, transmitting resolutions of directors pointing to control of lumber production as a necessary step in industrial reforestation and perpetual timber production. The resolutions spoke of "wasteful overproduction and consequent low prices of standing timber." At the same time, both softwood and hardwood manufacturers expect 1929 to be an even better year than 1928, particularly in the first quarter.

Good Labor Conditions

The high volume of construction continuing throughout the entire year developed much better labor conditions than existed in 1927. There has been neither marked unemployment nor shortages. The uptrend of skilled wages continued, but so also did the flattening tendency of the curve. The year-to-year rises of the average skilled rate since 1922 were in percentages as follows: 10, 8, 3, 3, 5, 2. In this six-year period the advance has been 35 per cent. The outlook is for a very slight increase in the average skilled rate this year.

Index numbers of wage rates in the building trades compare fairly closely with those in the manufacturing industries, but the actual wages are very much in favor of construction. Based on 1914 wages, the skilled building trades index is 239, while the index of all wage earners in 25 industries is 234. But whereas the average hourly wage in the manufacturing industries is $0.573 (for November), it was $1.35 for the building trades. The average rate for common labor in the building trades is $0.56.

The point of the matter is that in addition to much looser organization in manufacturing labor, these workers received much smaller wages in 1914 than did building mechanics. The average wage for the latter in 1914 was $0.56½, or about the same as the industrial workers are receiving today. The following figures for November, 1928, illustrate the point:

Bricklayers	$1.54	Automobiles	$0.710
Carpenters	1.18	Iron and steel	0.717
Ironworkers	1.33	Machine shop	0.641
Average	$1.35	Average	$0.689

Adequate Financing

Total capital issues of the last two years are valued at $9,927,736,770 in 1928 and $9,918,808,305 in 1927 (as against about five billions in each of the two years 1922 and 1923), according to the *Financial Chronicle*. These figures include bonds, stocks and notes for foreign loans, public utilities and corporations. Excluding foreign, farm loans and refunding, the new corporate issues for the last two years group as shown in the accompanying table.

NEW CAPITAL (REFUNDING EXCLUDED)

	1928	1927	Per Cent Change From 1927
Railroads	$364,000,000	$506,000,000	— 28
Public utilities	1,883,000,000	2,077,000,000	— 9
Iron, steel, copper	215,000,000	100,000,000	+ 115
Equipment	9,000,000	24,000,000	— 275
Motors	67,000,000	95,000,000	— 29
Other manufacturing	890,000,000	705,000,000	+ 26
Oil	216,000,000	317,000,000	— 32
Land and buildings	716,000,000	630,000,000	+ 14
Shipping	56,000,000	13,000,000	+ 331
Rubber	21,000,000	26,000,000	— 19
Miscellaneous	1,577,000,000	883,000,000	+ 79
Corporate	$6,014,000,000	$5,376,000,000	+ 12
Municipal	1,380,000,000	1,475,000,000	— 6
Total	$7,394,000,000	$6,851,000,000	+ 8

The increase in the value of corporate or industrial issues in 1928 is 12 per cent—which recalls the increase of 9 per cent in the value of heavy construction contracts for the year. It is important to note that contract letting lags several months behind new securities (see Fig. 8) where contracts are plotted four months after capital issues.

In view of the four to five months lag, the outlook for contract letting for the first part of 1929 lies in the new capital values of the last quarter of 1928. These, exclusive of foreign, farm and refunding, compare with those for the same quarter of 1927 as follows: 1928, $2,616,000,000; 1927, 1,914,000,000; third quarter 1928, $1,105,000,000.

The year closed with the largest month on record. Net flotations amounted to $1,116,000,000, compared with the average of $913,000,000 for the year and $581,000,000 in December, 1927. This record was made after an exceptionally slack summer, particularly with respect to municipal financing.

Prices Show High Stability

The best proof of the ability of the materials producers to supply the contracting industry is the stability with which prices have been maintained. The following average costs for the last four years tell the story:

	Average for Year				Feb. 1
	1925	1926	1927	1928	1929
Shapes, Pittsburgh	$1.99	$1.95	$1.83	$1.87	$1.90
Cement, Chicago	2.17	2.10	2.05	2.05	2.05
Pine, New York	59.66	62.16	61.45	61.16	63.00
Brick, New York	19.52	20.71	17.93	17.87	17.50
Hollow tile, Perth Amboy, N. J.	0.2487	0.252	0.2434	0.2489	0.252
Common labor, average	0.538	0.548	0.554	0.5558	0.559
Skilled, average	1.22	1.26	1.32	1.35	1.35
Construction Cost Index Number					
General construction	206	208	206	207	209
Building construction	203	204	203	203	...
Electric railway construction	202	203	201	203	...

While these rather scattered quotations indicate the soundness of the building materials market in general, there are of course certain materials whose prices have not held to the common level. Cast-iron pipe is one of these. At the beginning and at the end of 1928 quotations per net ton for 6-in. pipe were as follows: New York, $37.25 and $39.40; Chicago, $35 and $42.80; Birmingham, $27.50 and $38. Following are some bid and contract prices on specific projects early in 1928 and 1929:

	Per Ton
January, 1928	
Detroit, 4,000 tons	$35.05
Los Angeles, 60,000 ft. 6-in.	35.00
Jamesville, N. Y., 30,000 ft. 6-in.	43.50
Pasadena, Calif., 4,000 ft. 20-in.	37.00
Whittier, Calif., 1,500 ft. 8-in.	36.00
January, 1929	
Toledo, Ohio, 6,045 ft. 8-in.	32.50
Gould, Okla., 65,000 ft. 6-in.	48.50
Detroit, Mich., 2,900 tons 24-48 in.	41.42
Detroit, Mich., 105 tons Class H 12-20	54.00

Prices of brick fluctuated $1 in New York, but remained at the $12 level, held since 1925, in Chicago. Elsewhere there have been some declines, notably in Atlanta (—$4.35), Baltimore (—$3), Cincinnati (—$2.50) and San Francisco (—$1.50).

In lumber, the curtailment of production had its effect on prices in the case of yellow pine in the latter part of 1928. The following are typical rises since November: New York (3x12), $55 to $57, $57 to $59; Boston (3x12), $56 to $57; Kansas City (2x10), $42.80 to $45; Dallas (8x8), $57.50 to $65; still higher prices are looked for. Although this same practice has been in operation in the Northwestern fir region, prices have not yet been affected. They have been kept steady, however, and this is the prospect for 1929.

Maintained Volume Looked For

What of this year? The December figure for new securities sets a new peak. Only minor disputes are looked for in the labor field. Stability of the materials market will be maintained. There remains only the question of need.

This year's building volume alone is variously forecast at $7,100,000,000, $7,300,000,000 and $8,500,000,000. The last two estimates, based on surveys, look for a larger volume of building this year than last. The first estimate is on the basis that 1929 volume will approximate the average of the last four years, thus predicting a decline. In this connection it is important that building-permit figures in 354 cities show a consistent annual decline since 1925, last year's drop being 3.5 per cent. Should the same decline take place this year in all building, the total would still be more than seven billions. To obtain the figure for total construction, $1,500,000,000 for roads and $1,000,000,000 for other public works must be added to the $7,000,000,000 estimate for buildings—giving $9,500,000,000.

Glimpses at Other Industries

The electrical industry, like construction, accustomed to annual records, finds the rate of increase a little greater in 1928 than in other years. Gross revenue increased 8 per cent compared with 7 per cent in 1927. Ten per cent more energy was generated. The central-station budget for 1929 is estimated at $854,000,000, which is 9 per cent over last year's expenditures and reasonably matches the figures for increased production. Financing shows a drift from mortgage bonds. Security sales by light and power companies were $1,641,479,509 last year and $2,128,909,264 in 1927—23 per cent reduction. The arresting shift is that in the two years 1927 put $1,107,670,000 into bonds, 1928 only $438,870,000.

With Ford in production again, all seems right with the automotive world, and output is well ahead of 1927 for both passenger cars and trucks, the gain being 27 per cent and 17 per cent, respectively.

The chemical industry is still better off than it was a year ago. Its indexes of general activity—volume of soda ash, caustic soda, and sulphuric acid—all top the 1927 figures.

The steam railroads report relatively the best year (except 1926) since the war, and earned 4.73 per cent on total investment out of a permissible 5¾ per cent. In 1929 the American railroads are scheduled to place $800,000,000 in equipment and in property improvement, compared with $650,000,000 last year and $772,000,000

Table II—Large Contracts at Home and Abroad Placed in 1928

Project	Location	Owner	Contractor	Value
		Domestic		
Tunnel	Michigan and Ontario	Detroit-Ontario Subways, Inc.	Parklap, Inc., Detroit	$10,000,000
Hotel	New York	New York Hotel Corporation	Mack Kanner and J. S. Becker, N.Y.	20,000,000
Theater and office	Chicago	Chicago Civic Opera Co	John Griffiths & Sons, Chicago	20,000,000
Rayon plant	Richmond, Va.	Du Pont Rayon Co	Du Pont Engineering Co., Wilmington, Del.	10,000,000
Office and printing plant	Chicago	Chicago *Daily News*	Hegeman-Harris Co., Chicago	10,000,000
Bank and office	Chicago	Foreman National Bank	Paschen Bros., Chicago	10,000,000
Apparel manufacturers mart	Chicago	Apparel Mart Building Corporation	Starrett Building Co., Chicago	45,000,000
Bank and warehouse	New York	Lincoln Forty-Second Street Co	Dwight P. Robinson Co., New York	30,000,000
Office and hotel	Newark, N. J.	Lefcourt Realty Holdings	Separate contracts	10,000,000
Hotel, office and garage	Detroit	Detroit-Biltmore Hotel Co	Walbridge-Aldinger Co. and Otto Misch Co., Detroit	25,000,000
Hydro-electric plant	Augusta, Ga.	Savannah River Electric Co	Owner builds	20,000,000
Water tunnel	Yonkers to Brooklyn, N. Y.	Board of Water Supply, N. Y.	Patrick McGovern, Inc., New York	42,000,000
Rayon plant	Asheville, N. C.	American Enka Corporation	H. K. Ferguson Co., Cleveland	10,000,000
Gas pipe line	Texas and Nebraska	Texas Corporation	A. O. Smith Corporation, New York	9,000,000
Office building	New York	W. P. Chrysler	Fred T. Ley & Co., Inc., New York	12,000,000
Hydro-electric development	Springfield, Mo.	Empire Electric Co.	Company forces	16,700,000
Factory	Baltimore, Md.	Western Electric Co.	H. K. Ferguson Co., Cleveland, O.	15,000,000
		Foreign		
Roads (250 miles)	Spain	Spanish government	Fox Bros. International Corp., 33 Rector St., New York	$40,000,000
Power plants (5)	Spain	Segura & Jugar Hydro-electric Development Co	Fox Bros. International Corp	20,000,000
Airport	Spain	Compania Colon Transaereа, Seville, subsidiary Spanish government	Fox Bros. International Corp	5,000,000
Concrete roads (250 miles)	Spain	Compania Antovia Madrid Irum, subsidiary Spanish government	Fox Bros. International Corp	40,000,000
Railroads (750 miles)	Turkey	Turkish government	Fox Bros. International Corp	50,000,000
Harbors	Turkey	Turkish government	Fox Bros. International Corp	10,000,000
Railway	Caspian Sea to Persian Gulf	Persian government	Ulen & Co., Inc., 120 Bway, N. Y.	80,000,000
Foundry	Podolsky, Russia	U.S.S.R.	Frank D. Chase, Inc., 720 Michigan Ave., Chicago	1,000,000
Electrical apparatus and equipment	Russia	U.S.S.R., through Amtorg Trading Corp., 165 Bway, New York	International General Electric Co., 120 Bway., New York	26,000,000
Irrigation project	Greece	Greek government	Ulen & Co., Inc. and John Monks Sons, 120 Bway, New York	30,000,000
Electric light and bulb plant	Tokyo, Japan	Tokio Electric Co	H. K. Ferguson Co., Cleveland, O.	250,000
Railway (100 miles)	Bolivia	Bolivian government	Kennedy & Carey, 44 Wall St., N. Y.	12,000,000
Paving, sanitation, water-works, etc.	Puerto Limon, Costa Rica	City	R. W. Hebard & Co., Inc., New York	600,000
Roads (135 miles)	Costa Rica	Costa Rican government	Simmons Constr. Co., Charlotte, N.C.	3,000,000
Dam	Mexico	Government of North Dist.	Amburson Constr. Co., Grand Central Terminal, New York	3,000,000
Power plant	Valdivia Lake, Chile	Electro Siderurgical de Valdivia, Valparaiso, subsidiary Chilean govt.	J. G. White Eng. Corp., 43 Exchange Place, New York	6,000,000
Smeltery	Port Correa, Chile			
Railroad	Colombia, S. A.	Ferrocarrel Central del Norte	R. W. Hebard & Co., Inc., 32 Bway, New York	7,000,000

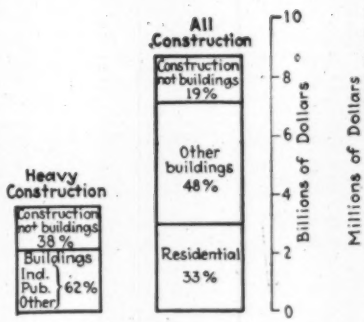


Fig. 1

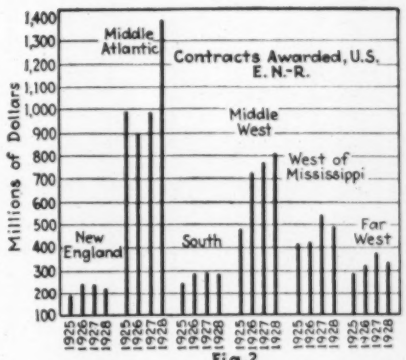


Fig. 2

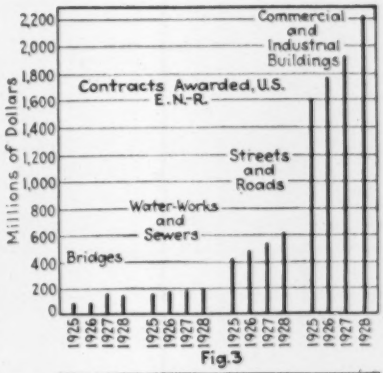


Fig. 3

Fig. 4

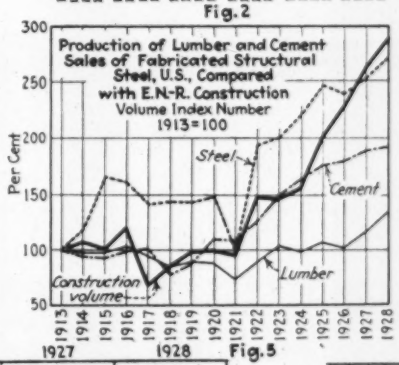


Fig. 5

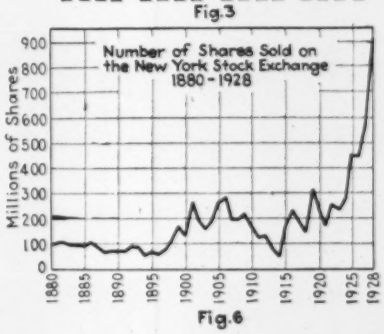


Fig. 6

New capital (4 months ahead of contracts)
New capital bonds, stocks and notes
Contracts awarded, E.N.-R.
Contracts (4 months behind capital)
Millions of Dollars

Fig. 8

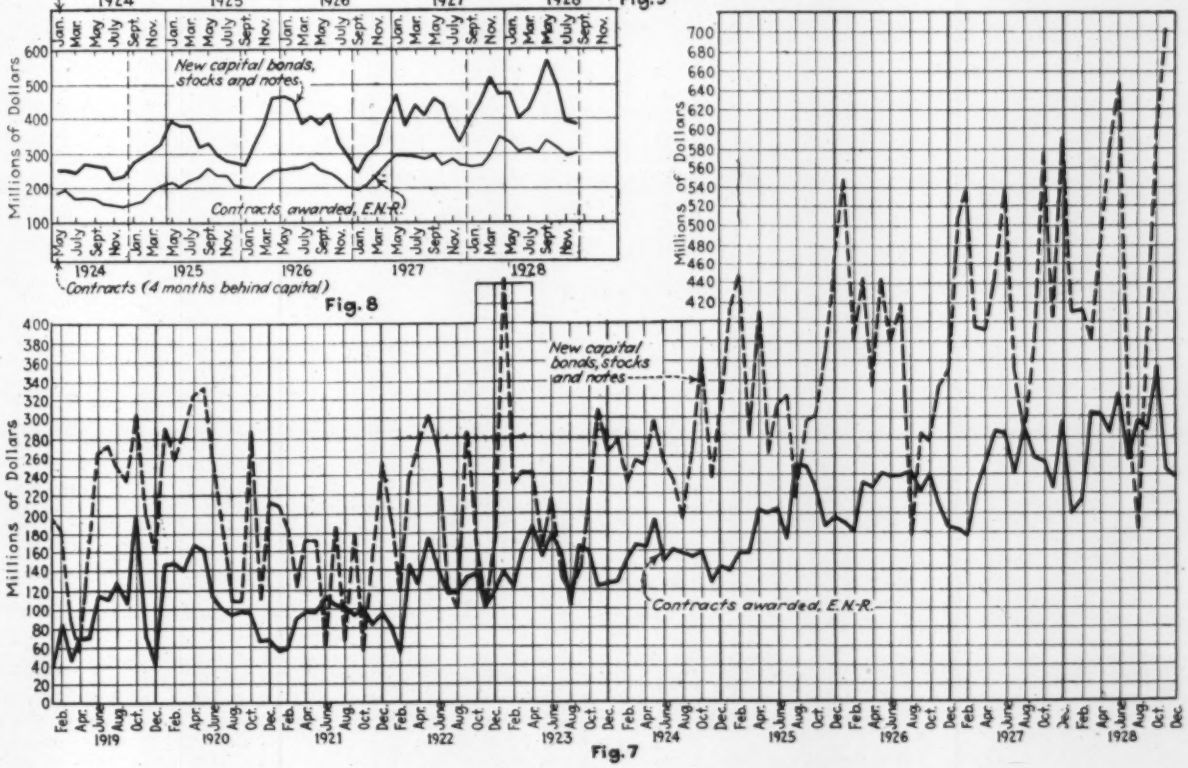


Fig. 7

FIG. 1—PRINCIPAL DIVISIONS OF CONSTRUCTION, 1927 AND 1928.

FIG. 2—GEOGRAPHICAL DISTRIBUTION OF CONSTRUCTION CONTRACTS IN EACH SECTION, 1925-28.

FIG. 3—ANNUAL VALUE OF CONTRACTS IN EACH CLASS, 1925-28.

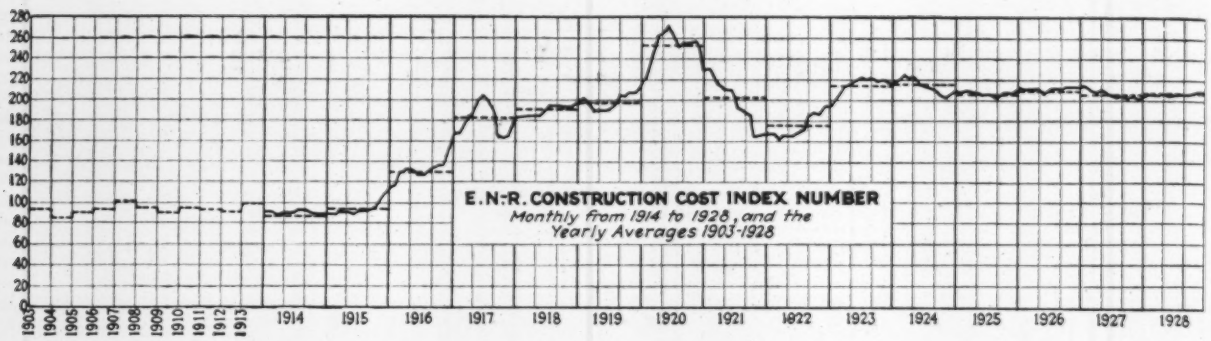
FIG. 4—VALUE INDUSTRIAL BUILDING CONTRACTS AWARDED SINCE 1913.

FIG. 5—ANNUAL VOLUMES OF PRINCIPAL MATERIALS, 1925-28.

FIG. 6—NUMBER OF SHARES SOLD ON NEW YORK STOCK EXCHANGE, 1880-1928.

FIG. 7—VALUE OF NEW CAPITAL ISSUES AND HEAVY CONSTRUCTION CONTRACTS, 1919-28.

FIG. 8—CONTRACTS 1924-28, PLOTTED FOUR MONTHS AFTER CAPITAL ISSUES



in 1927. In the last six years the proportional amount spent for equipment has been steadily declining, from 64 per cent in 1923 to 33 per cent in 1928, with an equal increase for roadway, 36 per cent in 1923 and 67 per cent in 1928.

Radio announces its biggest year, beating 1926, the previous record, by 1,200,000 sets sold at retail, total sales being 2,550,000. Total volume of retail business amounted to $650,550,000, compared with $425,600,000 in 1927.

Manufacture of aircraft is another young and coming industry. Production in 1928 reached 4,000, compared with 2,000 in 1927, and this year 10,000 to 12,000 is predicted.

Metal mining finds promise in the highest copper price since 1920. The year started with 14c.; no such bonanza as 17c. was expected, but it is here. Prices of lead, zinc and tin averaged less in 1928 than in 1927. Even coal and textiles, the "unholy twins," express hope. The coal industry claims to be "fundamentally" or "psychologically" in a better condition than at any time in the last ten years, due principally to the phenomenon of its leaders sitting down at the same table. "Textiles," according to the National Industrial Conference Board, "as a group showed a decline of about 4 per cent; cotton consumption was about 11 per cent less and wool mill activity about 5 per cent less than last year. The output of both bituminous and anthracite coal was 5 per cent smaller than in 1927."

Efficient effort, with resulting economy, continues to be an important note and may in a measure help account for the faintness of the "profitless prosperity" plaint of a year ago. That the ideal has not yet been attained is best illustrated, perhaps, by the annual decrease in the pounds of coal needed to generate a kilowatt-hour. There has been no pause in this decrease since 1919. With gross incomes smaller than a year ago and net income greater, the railroads point to trimming of operating expense and labor, in heavier loads, greater speeds, lower unit fuel consumption, fewer repairs through better equipment and fewer delays due to failures. In the matter of coal, the 1928 drive for underground machine loading has created the current problem of fast mechanical preparation of coal at the top-works, and its solution seems to be the efficiency keynote for 1929. In the metal-working industry 326 new machines and other pieces of equipment were announced in the last six months—many more than even in the preceding six months. Higher production is the urge, and this introduction of greater speed is going on among all types, even those as standard as lathes, milling and drilling machines, and grinders. That the construction industry has progressed similarly in more efficient handling of men, materials and equipment was brought out in the opening pages of this issue.

Table III—Large Domestic and Foreign Projects Under Consideration for Award

Project	Location	Owner	Value
Domestic			
Bridge	California, over Suisun Bay between Martines and Army Point		$12,000,000
Bridge	Maryland	Chesapeake Bay Bridge Co., Baltimore	10,000,000
Sewers, storm and sanitary	Michigan	Oakland, Macomb, Lapeer and St. Clair Counties	9,000,000
Terminal	Jersey City, N. J.	Pennsylvania Railroad Co., Philadelphia	40,000,000
Electrification	Part of system	Pennsylvania Railroad Co., Philadelphia	10,000,000
Hydro-electric development	Clarksville, Va.	Roanoke River Power Co., Viele, Blackwell & Buck, surveying engineers, 49 Wall St., New York	10,000,000
Dams (2)	Charleston, W. Va.	New Kanawha Power Co., subsidiary of Union Carbide & Carbon Co., New York	7,000,000
Hydro-electric development	Great Falls, Mont.	Montana Power Co., subsidiary of American Power & Light Co., New York	4,000,000
Electric generating plant	Sayreville, N. J.	Eastern New Jersey Power Co.	6,000,000
Power plant	South Amboy, N. J.	Jersey Central Power & Light Co., Morristown, N. J.	5,000,000
Nitrogen plant	Hopewell, Va.	Atmospheric Nitrogen Co., Syracuse, N. Y.	35,000,000
Oil refinery	Mariner Harbor, N. Y.	Gulf Refining Co., Pittsburgh	45,000,000
Pipe mill	McKeesport, Pa.	National Tube Co., subsidiary of U. S. Steel Corp.	20,000,000
Pipe mill	Ambridge, Pa.	A. M. Beyers Co., Pittsburgh	20,000,000
Office building	New York	Three-Hundred-Thirty West Forty-second Street Corporation	22,500,000
Foreign			
Aswan dam—increasing height	Egypt	Government; H. L. Cooper, 101 Park Ave., New York, member of advisory committee	$10,000,000
Highways (153 miles)	Mexico	Government	3,000,000
Water-supply system	Colombia, S. A.	City of Bogota	.....
Automatic telephone system, hydro-electric plant and traffic elevators	Bolivia, Brazil	Empresas Electricas Brasileiras; American Foreign Power Co.; Electric Bond & Share Co.	18,750,000
College buildings	Kamehaeha, T. H.		3,500,000
Dam and power plant	Vranov, Moravia, Czechoslovakia	Ministry of Public Works, Prague	3,294,000
Channel and port improvement, fortifications, capital	Canton, China	Nationalist government	.....
Railroad (300 miles)	Peru	Peruvian government	.....
Road improvement	Morocco	Spanish Moroccan government	7,000,000
Roads and bridges	Transvaal, South Africa	Government, Union of South Africa	3,163,000
Milk condensary	Province of Bayamo Oriente, Cuba		2,000,000
Paving, 621 kilometers; 126 bridges; 677 drawbridges	Buenos Aires, Rosario, Cordoba	Argentine government	22,266,000

News of the Week

Surety Companies Affiliate With Associated General Contractors

Thirteen corporate surety bonding companies representing about 70 per cent of the national surety bond business organized in New York City Jan. 31 a surety bonding affiliated bureau of the Associated General Contractors. The object of the affiliation is to provide closer contact between the construction industries and the surety companies, to create a better understanding and greater appreciation of mutual problems and to promulgate joint action of direct benefit to the construction industry and the surety companies. E. A. St. John, president, National Surety Company, was elected chairman of the new bureau, and S. M. Williams, manager, Engineering Construction Division, A.G.C., was elected manager. The initial membership consists of the following companies: The Aetna Casualty & Surety Company, Hartford, Conn.; American Surety Company of New York, New York; Continental Casualty Company, Chicago, Ill.; Fidelity & Deposit Company, Baltimore, Md.; Globe Indemnity Company, Newark, N. J.; Great American Indemnity Company, New York; Independence Indemnity Company, Philadelphia, Pa.; Maryland Casualty Company, Baltimore, Md.; Metropolitan Casualty Company, New York; National Surety Company, New York; Southern Surety Company, St. Louis, Mo.; Standard Accident Company, Detroit, Mich.; and United States Fidelity & Guaranty Company, Baltimore, Md.

Bill Proposes Prequalification of New York State Contractors

Prequalification of prospective bidders on public work in the State of New York is proposed in a bill introduced in the state legislature amending the public works law and the general municipal law.

The measure provides that before a person, firm or corporation may receive plans and specifications so as to bid on any public state or municipal work for which contracts are advertised evidence of responsibility in such form and in such method as will satisfy the state or municipal officer that the bidder is qualified to bid must be submitted.

There is no straight court review of the action of the officer in determining the qualifications of the prospective bidder. The bill, however, says, "but this section shall not be construed as preventing a review, by certiorari or otherwise, of the determination of the awarding officer as to the qualifications of any prospective bidder to undertake and fully perform, in a satisfactory manner, the work contemplated."

New Texas Rail Lines Proposed

The South Plains & Santa Fe Railway Company has petitioned the Interstate Commerce Commission for permission to construct a new line from Seagraves, Tex., to Lovington, N. M., and a branch off the new line, a total length of 89.5 miles.

Authority for a 40-mile extension of the Arkansas City branch of the St. Louis-San Francisco Railroad from Vernon to Seymour, Tex., has been requested by that road. At the same time the Frisco asks permission to purchase the Gulf, Texas & Western for a consideration of $2,300,000 and to extend the G.T.&W. from Seymour to Paducah, Tex., a distance of 70 miles.

Barges and Tide Place Lift Span on San Francisco Bay Bridge

The 303-ft. central lift span of the San Mateo-Hayward bridge across San Francisco Bay, weighing 617 tons, was towed 8 miles to position, maneuvered into place in twenty minutes and seated by the receding tide on Jan. 26. After assembly at a site on the bay shore, the span was moved out over the water and two barges with timber cribbing 35 ft. high were allowed to take the load on a rising tide. The barges were equipped with double-drum hoists and when the site was reached lines were run to anchors placed up and down stream giving complete control to movement of the span.

F. L. Holser & Company, Los Angeles, sub-contractors on steel erection, placed the lift span. The 7-mile highway toll bridge is scheduled to open to traffic Feb. 22.

Moffat Railroad Disputes Rental Terms for Use of Tunnel

The Denver & Salt Lake (Moffat) Railroad has refused to pay an annual rental charge of $560,066.64 named by the Moffat Tunnel Commission for use of the 6-mile tunnel under James Peak in Colorado. The railroad claims it has fulfilled its obligations to date in paying $292,209.48 rent for the tunnel's use since Feb. 14, 1928. When the contract was made for the use of the tunnel the rental charge was based upon a rate of 66⅔ per cent of the interest of the two outstanding bond issues of $6,720,000 and $2,500,000 which had been floated by the commission to cover the tunnel construction and 66⅔ per cent of the principal as the bonds would mature. At that time it was unknown that the bond issues would total $15,470,000. The tunnel commission is now suing to collect rent based on the interest on the total bonds, while the railroad claims it is not obligated to pay on the additional issues. Injunction procedure against the railroad's continued use of the tunnel has been threatened, with the road hinting that it will return to operation over the 23-mile line over the range through Rollins Pass, which was used before the opening of the tunnel. The rental claimed by the commission includes $12,000, two-thirds of the annual expense for the maintenance of the tunnel commission.

Lake Pontchartrain Toll Bridge in Hands of Receivers

The Pontchartrain Bridge Corporation, operator of the long toll bridge over Lake Pontchartrain near New Orleans, has been placed in the hands of receivers by United States District Judge Wayne Borah, on petition of Jahncke Service, Inc. The bridge company declares it is solvent and that the receivership will not interfere with the operation of the project.

Status of Two Proposed Bridges at New Orleans

Before approving an extension of the time for the construction of the bridge over the Mississippi River at Twelve-Mile Point, above New Orleans, the Chief of Engineers required an alteration of the plans under which the vertical clearance must be increased to 135 ft. above the flood stage of the river, which now is 20 ft. on the Carrollton gage. No change was made in the horizontal clearance between spans, which remains 750 ft. The project is in charge of the Public Belt Railroad Commission, a state agency. A bond issue of $15,000,000 has been authorized by the state. The bridge is to be used for both railroad and vehicular traffic. Negotiations with the railroads for the use of the bridge are now in an advanced stage.

Hero-Hackett Brdge

The House of Representatives, on Feb. 4, approved an extension of three years in the period for the construction of the Hero-Hackett bridge. This proposed structure would connect the business section of New Orleans with the west bank. The Chief of Engineers has refused to approve the original plans submitted for this bridge and has indicated that he would approve no bridge at a location which would divide the harbor. He has consented, however, to a reopening of the case to consider new plans. These plans will be discussed at a public hearing to be held in New Orleans Feb. 14. At a special meeting Jan. 29 the Board of Commissioners of the Port of New Orleans gave permission for the construction of the bridge.

Flood-Control Plan for Lake Okeechobee Recommended

A comprehensive flood-control plan for the Lake Okeechobee district of Florida which will cost the federal government $4,000,000 and local interests $6,740,000 is recommended by Major-Gen. Edgar Jadwin, Chief of Engineers, in a report to the House committee on rivers and harbors. General Jadwin recommends that the lake level be maintained at El. 17, and rock levees constructed on the north and south shores to El. 31. The report discourages the diversion of the Kissimmee River directly to the Atlantic, stating that additional outlet capacity through the Caloosahatchee River should be provided for to keep the lake level down to El. 17. As a navigation as well as a flood-control project, the report recommends that a channel 6 ft. deep and at least 80 ft. wide be provided for from Lake Okeechobee to Fort Myers and that the Taylors Creek channel to Okeechobee City be improved.

Texas Water-Works Short School Draws Record Attendance

The eleventh annual short school conducted in Texas for water and sewer plant operators under the joint auspices of the sanitary engineering division of the Texas State Department of Health and the Texas Section of the Southwest Water Works Association, met in Bryan, Jan. 23-25, with a total attendance of 200. About 30 water and sewer plant operators were found to be in regular attendance for the ten days' laboratory section program, practically all of whom expressed a desire of making the short course permanent either at A. & M. College or the University of Texas. The feature lecturer for the general sessions and convention was E. Sherman Chase, of Metcalf & Eddy, Boston, Mass. Mr. Chase's lecture on "Protection of Reservoirs and Watersheds" was especially of interest to Texas at this time due to the apparent divided interest on this subject.

Columbia Offers Short Courses on Concrete Mixtures

Columbia University, New York City, in conjunction with the Portland Cement Association, will offer a series of special laboratory short courses in the design and control of concrete mixtures, the first session beginning Feb. 19. The course is given for the benefit of engineers, architects and contractors who have not had an opportunity to keep up with the latest practices in concrete design and control. Lectures will supplement each laboratory session. No tuition, except a $5 laboratory fee, will be charged for the course. Applications should be made to L. E. Andrews, Portland Cement Association, 347 Madison Ave., New York, N. Y.,

Review of Year's Work Shows Illinois Society Extending Activities

Chicago Meeting Reveals That Increased Membership and Public Recognition Are Results of Extended Service

SYSTEMATIC broadening of the activities of the Illinois Society of Engineers, to benefit both engineers and the public, was noted in a review of the work of the society at its annual meeting held in Chicago on Jan. 23 to 25. These increased activities have resulted in a considerable increase in membership. During 1928 two local chapters were organized and two more are in the preliminary stages; five local meetings were held in different cities, and short courses in concrete engineering were held in several cities. Furthermore, a special committee on engineering extension work urged that this new line of educational work should be continued and enlarged, since the engineer as a public servant should render non-technical as well as technical service. This report, which was approved, proposed the establishment of a special department or branch to conduct the extension work.

Somewhat along this line was a paper by Dr. N. O. Gunderson, health commissioner of Rockford, Ill., explaining the publicity methods employed in informing the public as to the purposes and advantages of a local sanitary district and thus obtaining an intelligent and favorable vote on the necessary bond issue. As to the cost, this campaign showed not only how much it would be and how it would be distributed, but also how little it would be, when reckoned on the basis of a $100 property valuation unit, for the term of years covered by the bonds. As a result of study of actual conditions of sewage-works in Illinois, C. E. Schwob, assistant engineer in the State Department of Public Health, suggested that the designing engineers of such plants ought to be retained in consulting capacity for a year, to get the plant working properly, and then in an advisory capacity to inspect and report upon the operation and condition of the works.

Building Designers Criticised

Criticisms of building designers were emphasized by Loran D. Gayton, city engineer of Chicago, in a paper on building inspection and building code enforcement. He remarked upon a prevailing tendency of architects and consulting engineers to employ only low-salaried men of limited experience and to intrust them with the design of important structures, instead of employing qualified men at higher salaries. One result is that men are not encouraged to follow engineering work, and if employers of technical men do not wake up to this fact the outcome will be bad for them and for the country. The employment of inexperienced and poorly paid men on important work is far from economical in the long run. Cases were cited of exceptionally bad or weak design, in which the employing engineers objected indignantly to criticisms of their designs until shown the calculations made in the building department. It then appeared that the plans were made by ordinary draftsmen and not by real designers.

Traffic Problems Discussed

Traffic as a neglected factor in plans for traffic control was cited in regard to both highways and city streets. Many highways are inadequate for the traffic they carry, while others have much more capacity than is needed. In city control, lights are often installed arbitrarily and while left-hand turns are often prohibited, the right-hand turn is generally overlooked as a troublesome feature in traffic regulation. A gasoline tax for the improvement of the system of secondary roads was advocated by D. O. Thomas, a county superintendent of roads. As to paving contracts, A. W. Consoer, of Chicago, suggested that it is for the engineer to make the public realize that when he recommends an award to some other than the lowest bidder he is acting solely for the interest and protection of the public. Reclamation of land in northern Illinois for summer residences and communities was an unusual aspect of drainage and reclamation work covered in a paper by W. G. Potter, assistant engineer of the State Waterways Division.

Officers for 1929 include: President, M. L. Enger, professor of mechanics and hydraulics, University of Illinois, Urbana, Ill.; vice-president, David O. Thomas, county superintendent of highways, Belleville, Ill.; secretary, H. E. Babbitt, Urbana, Ill. The next annual meeting will be held at East St. Louis, Ill., in January, 1930.

Iowa Engineering Society Ready for Increased Activties

At the annual meeting of the Iowa Engineering Society held in Des Moines Jan. 30 to Feb. 1 President E. L. Waterman indicated that while the society's membership is at present but half of the 537 of 1923, it has paid all back debts and is ready to enter into a wider line of activities of better service to its members and to the state by fostering sectional meetings and clubs. Members were urged to take a more active part in public service. The society felt the depression prevalent in the state following the deflation period 1922 and 1923, but is now well on the upward grade, according to Mr. Waterman.

As in previous years, the society devoted one session to its sections covering drainage, highways, mechanical, electrical and railroad engineering, municipal engineering and city planning and structural-architectural engineering. All but the drainage engineers held sessions this year. Joint sessions were held with the Iowa Town Planning Association at which the newer topics of regional planning and airports were covered.

Wood Preservers Discuss Trend of the Industry

Chemical and practical aspects of wood preservatives and their varied uses were featured at the 21st annual meeting of the American Wood Preservers Association, held at Louisville, Ky., on Jan. 22 to 24. No great increase is to be expected in the number of ties treated annually, according to G. B. Shipley, Pittsburgh, Pa., since the number now treated represents about 72 per cent of all ties purchased. In fact, ties form now only 64 per cent of all material treated, a decline from 82 per cent about twenty years ago, indicating a material increase in the treatment of lumber and miscellaneous wood products. There are opportunities also in the further use of salt treatments where creosote oil is objectionable, as in mills, dwellings and other structures in which a clean or painted surface is desirable. Development in treating unseasoned hardwoods by the boiling process is an illustration of the possibilities of extending the market by adapting preservative processes to new requirements. There is also a marked increase in the use of creosote-petroleum mixtures, in order to reduce the cost of preservative, but care must be taken not to weaken the toxicity by too great a dilution with petroleum.

Absorption of preservative based on dimensions of the timber rather than on net retention per cubic yard was advocated by J. D. MacLean, U. S. Forest Products Laboratory. This paper was abstracted in *Engineering News-Record*, Jan. 31, p. 176. A committee appointed to prepare specifications for the treatment of Douglas fir found the mixtures so variable that it was not possible to come to any agreement and further time is needed. In car lumber, creosote is used successfully for stock and open-top cars. But for closed and refrigerator cars a colorless and odorless preservative is needed, and no such material of sufficient toxicity and permanency is now available, according to another committee. In a report giving records of tie service, it was noted that in nineteen years' service on the Chicago, Burlington & Quincy Railroad 99 per cent of untreated ties were removed, while removals of treated ties were 25, 53 and 71 per cent for creosote, zinc-creosote and straight zinc, respectively. An important paper on termites or white ants, their increasing destructiveness and the methods taken to exterminate them was presented by T. E. Snyder, U. S. Department of Agriculture. Experience with treated timber on the Illinois Central Railroad was told by A. F. Blaess, chief engineer.

Officers elected for 1929 are as follows: President, H. E. Horrocks, Pacific Creosoting Company, Seattle, Wash.; vice-presidents, C. C. Cook, maintenance engineer, Baltimore & Ohio Railroad, Baltimore, Md., and J. S. Penney, T. J. Moss Tie Company, St. Louis, Mo.; secretary, H. L. Dawson, Chicago. It was voted to hold the 1930 meeting at Seattle, Wash.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Budd Mentioned as War Secretary—Muscle Shoals Offer Is Unfavored—Hydraulic Laboratory Bill Doomed

THE NAME of Ralph Budd is being discussed as a Cabinet possibility. Rumor in Washington has it that the engineer who is president of the Great Northern Railroad Company has been suggested as one who could render particularly valuable service at this time as Secretary of War. Because of the differences which have arisen between the army engineers and the outside engineers, no one would be surprised were President-elect Hoover to put an outstanding civil engineer at the head of the War Department with the idea that this would facilitate better understanding between the two groups.

Muscle Shoals Offer

The amended Muscle Shoals offer of the American Cyanamid Company is strongly opposed by the two Alabama Senators, who claim that it contains "no semblance of a guarantee for fertilizer manufacture." In addition, they say in a joint statement: "We cannot and will not support any measure which fails to guarantee this great boon to agriculture. In our judgment, the production of fertilizer is paramount and the utilization of power is secondary."

Hydraulic Laboratory Bill

After a week of hearings before the rivers and harbors committee of the House indications all are that the hydraulic laboratory bill will not be allowed to pass at this session. The measure already has been approved by the Senate. It is even doubtful if the committee will report the bill favorably, as Chairman Dempsey very clearly is hostile to the measure. In the event a majority of the committee should vote to report the bill it is believed that its opponents have enough influence to prevent its coming before the House. Friends of the Corps of Engineers in Congress regard the measure as an attempt of engineers outside the government service to use it as an entering wedge in the effort to limit the authority of the Corps of Engineers and to place a portion of the work of that agency under civilian direction. This is in spite of the fact that American Engineering Council, the chief proponent of the bill, and Senator Ransdell, its author, have consented to amendments specifying that the national hydraulic laboratory is to undertake river and harbor problems only at the request of the Secretary of War.

A. W. Berresford, president of American Engineering Council, and George K. Burgess, director of the Bureau of Standards, were witnesses appearing in behalf of the measure. Mr. Berresford explained that the laboratory could work to the greatest advantage for at least five years on hydraulic problems now faced by bureaus outside of the War Department

Further evidence was given to the necessity of locating a hydraulic laboratory at the Bureau of Standards by representatives of the Geological Survey and Reclamation Service who were afforded an opportunity to testify on Feb. 5. N. C. Grover, chief hydraulic engineer of the Geological Survey, after stating that a hydraulic laboratory would be extremely useful in checking the accuracy of current meters, told the committee that the Geological Survey had been compelled on several occasions to consult university laboratories in connection with its work. He admitted that the survey does not have enough work to justify the building of a laboratory entirely for its own purposes.

Chairman Dempsey, of the committee, expressed surprise at this point that the Geological Survey concerned itself with any other problems than these relating to the study of rock formations. Proceeding further with his questions, Mr. Dempsey, aided by Representative McDuffee of Alabama, inquired as to the motives of the civil engineering profession in supporting the bill. These Representatives expressed the opinion that civil engineers have no interest in hydraulics except in connection with work on power projects. In reply, Mr. Grover stated that many civil engineers are employed by cities, in addition to municipal engineers, for designing and constructing sewage plants and water-works. He added that a great deal of the irrigating work is done by engineers outside the Reclamation Service. C. A. Bissel, of the Reclamation Bureau, testified that the Reclamation Service has long felt the need for a laboratory such as is proposed in the bill under consideration. In answer to questions interposed by members of the committee he expressed the opinion that the Reclamation Service would probably be able to save enough out of the laboratory experiments in connection with some of its large dams to pay the entire cost of installation. In developing this point, he stated that the proposed laboratory would prove invaluable in fixing upon the principles of design to be employed in the construction of the Boulder dam project.

Federal Aid for Flood Damage

An appropriation of $3,654,000 to be used in reimbursing the states of Louisiana, Arkansas, Mississippi and Missouri for expenditures made in repairing roads and bridges destroyed by the floods of 1927 is provided in a measure that recently was reported favorably by the Senate agricultural committee. An amendment was agreed upon, however, making it necessary for the states to show that they have spent or have committed themselves to spend an amount equal to that which they seek to obtain from the federal government before any aid is extended. Under the terms of the bill, Arkansas is allotted $1,804,000, Louisiana $967,582, Mississippi $628,000 and Missouri $258,418.

Michigan Highway Conference

The fifteenth annual Michigan Highway Engineering Conference will be held at the University of Michigan, Ann Arbor, Feb. 20-23, instead of Feb. 19-22, as previously announced. Under the revised program, the first session will be a smoker at the Michigan Union, Wednesday evening, Feb. 20.

Condemnation of Water-Works for Paterson Halted

Appointment of a condemnation commission to fix the price to be paid by Paterson, Passaic and Clifton, N. J., for the property of the Passaic Consolidated Water Company was held illegal by the New Jersey Court of Errors and Appeals on Feb. 4, reversing an earlier decision by the state Supreme Court. The higher court holds that the New Jersey eminent domain act of 1923 is of doubtful meaning and that it should be revised by the legislature, which is now in session. The taking of testimony on the value of the property has been going on for some time.

Personal Notes

RALPH SMILLIE has recently been appointed by the department of public affairs of the city of Newark, N. J., to take charge of the design and construction of the new city railway in that city. He was formerly engineer of designs of the Holland tunnel.

H. F. PARSONS has been appointed general manager of the Edward Ehrbar Company, Brooklyn, N. Y. Mr. Parsons is a civil engineer and a graduate of the class of 1910, Massachusetts Institute of Technology.

FRANK T. SHEETS has been reappointed chief engineer of the Illinois State Highway Department by Governor Emmerson. Mr. Sheets has been associated with the department for 22 years.

GORDON E. SISSONS, who for the past three years has been associated with the engineering division of Stevens & Wood, Inc., New York City, has accepted a position as designing engineer with the United Engineers & Constructors of Philadelphia, and will be engaged on the terminal improvements of the Pennsylvania Railroad at that city. Mr. Sissons previously was assistant engineer with the New York and New Jersey Bridge and Tunnel Commission on the Holland vehicular tunnel.

JOHN D. WALDROP, assistant state highway engineer, has been named as acting state highway engineer of North Carolina, to succeed LESLIE R. AMES, resigned. W. D. SOMERVELL, of Durham, fourth district engineer, was appointed to the place vacated by Mr. Waldrop, and D. M. RAY, assistant district engineer, was named to succeed Mr. Somervell.

FRANK L. RASCHIG, formerly with the Cincinnati Rapid Transit Commission, has been named deputy engineer of construction of the Ohio State Highway Department. JOHN B. BAIN has been appointed auditor of the department.

G. GIFFORD SYMES has opened an office in the Berkshire Life Building, Pittsfield, Mass., for the practice of engineering, specializing in building construction. For the past five years he has been with H. Van Buren Magonigle, architect, during which period he was in direct charge of the construction of the Liberty Memorial at Kansas City, Mo., and other memorials. Previous to that time he had been connected with engineers and contractors in the constructions of buildings throughout the East and West.

Obituary

FRANK H. MILLS, for 33 years city engineer of Woonsocket, R. I., died on Jan. 2 in his 76th year.

SAMUEL WYLIE MILLER, consulting engineer of the Union Carbide & Carbon Company's research laboratories in Long Island City, N. Y., since 1921 and an authority on welding, died on Feb. 3 at his home in Hollis, L. I., aged 62. He was credited with being one of the first to visualize the possibilities of oxyacetylene welding, of which he made a special study. He often lectured before engineering societies and wrote several books on the subject. Mr. Miller was a past-president of the American Welding Society.

LOUIS ALBERT HEQUEMBOURG died at his home in Oswego, N. Y., on Jan. 27 from pneumonia. Mr. Hequembourg was formerly a junior engineer in the state engineer's office and also had been engaged on construction work in the Manhattan subway. For several years he was with the Carlisle organizations on hydro-electric developments in northern New York, also the two power plants at Oswego. Three months ago he opened a consulting engineer's office in Oswego. He was 43 years old.

WILLIAM EDWARD MULLINS, former general traffic manager of the United Fruit Company and an engineer to whom much of the planning and building of the International Railroad of Central America was due, is dead in New York, aged 56 years. Soon after his graduation from the University of Toronto, Mr. Mullins was appointed general superintendent of the Vermont Central Railroad while still in his twenties. In 1906 he went to Central America, where he remained until 1915, returning to New York to become general traffic manager of the United Fruit Company, which position he held until 1920. Then he returned to Central America, but ill health compelled him to give up work there about a year ago. Mr. Mullins was the builder of the Lemba bridge in Salvador.

CORNELIUS J. O'CONNOR, a division engineer of the New York City Board of Water Supply, died Jan. 30 at the age of 53. Mr. O'Connor had been connected with the Board of Water Supply for seventeen years and aided in the construction of the Kensico and Schoharie dams.

DAVID E. MCCOMB, retired engineer of bridges of the District of Columbia, died on Jan. 27. Mr. McComb was 79 years old and had spent more than 50 years in the service of the district, having a part in the building of many of the bridges of Washington. He left the district service on several occasions, once to assist in the building of the Panama Canal.

Engineering Societies

CALENDAR

ANNUAL MEETINGS

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; annual convention, Detroit, Mich., Feb. 12-14.

ENGINEERING INSTITUTE OF CANADA, Montreal, Que.; annual general and general professional meeting, Hamilton, Ont., Feb. 13-15.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington, D. C.; annual convention, Chicago, Ill., Feb. 18-22.

NATIONAL DRAINAGE CONGRESS, Kansas City, Mo.; annual convention, Memphis, Tenn., Feb. 19-21.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago; annual convention, Chicago, March 5-7.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; spring meeting, Dallas, Tex., April 24-26.

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THE BOSTON SOCIETY OF CIVIL ENGINEERS will hold a joint meeting on Feb. 20 with the engineering societies of Massachusetts Institute of Technology, Harvard, Tufts and Northeastern University, which will be addressed by William H. Uhl. Mr. Uhl will describe the development of 745 ft. of fall on the Mongoup River which involves the construction of five hydro-electric plants with a total capacity of 40,000 hp. Three of these plants are completed and the fourth is under construction.

THE ENGINEERS CLUB OF OMAHA has recently elected officers as follows: President, P. K. Harlan; vice-president, John Ripley; secretary, Art Walker; treasurer, John Schultz; past-president, R. H. Findley. The club is now six years old and has a membership of 300.

THE NEW ENGLAND WATER WORKS ASSOCIATION will hold its February meeting at the City Club, Boston, on Feb. 13, at 1 p. m. The Granville dam will be the subject of discussion and the speakers will be C. A. Farwell and E. B. Myott, both of the consulting engineering firm of Fay, Spofford & Thorndike, Boston.

THE AFFILIATED TECHNICAL SOCIETIES OF BOSTON held an aviation meeting and dinner on Feb. 6, at which leading figures in aeronautics made addresses.

Monthly Review of Construction

January Contracts and Costs

Engineering contracts reported awarded in January total $396,833,000. This is at the rate of $79,500,000 per week, which is 60 per cent higher than in January, 1928, and 54 per cent higher than in December. The gain over a year ago is general, both geographically and according to classes.

Industrial buildings show an unusually large increase, the total for the month amounting to 22 per cent of the value in the whole of 1928. The explanation is a $45,000,000 oil refinery at Mariner Harbor, N. Y., to be built by the Gulf Refining Company.

The unclassified division is also high, helped by a $45,000,000 telephone extension in Missouri for the Southern Bell Telephone Company. Another contract deserving special mention is an irrigation system at Raymondville, Tex., for the Wallace County Water Control and Improvement District, estimated to cost $7,500,000.

Construction Cost and Volume Index Numbers

E.N.-R. Cost		E.N.-R. Volume*	
Feb. 1929	**210.40**	**Jan. 1929**	**325**
Jan., 1929	209.40	Dec. 1928	244
Feb., 1928	204.65	Jan., 1928	208
Peak June, 1920	273.80	1928 (average)	287
1928 (average)	206.78	1927 (average)	263
1913 (average)	100.00		
1927		1927	
January	211.50	January	187
February	210.15	February	182
March	208.80	March	226
April	209.00	April	257
May	206.80	May	299
June	205.55	June	297
July	203.68	July	252
August	205.50	August	306
September	203.60	September	273
October	204.40	October	269
November	201.98	November	272
December	203.90	December	319
1928		1928	
January	203.90	January	208
February	204.65	February	225
March	204.65	March	318
April	206.40	April	316
May	207.00	May	299
June	206.15	June	308
July	206.65	July	266
August	207.29	August	306
September	207.29	September	296
October	207.71	October	363
November	209.46	November	251
December	210.15	December	244

*Corrected for price changes.

Steel Quiet at Pittsburgh; Active in Chicago

Reports from Pittsburgh state that steel buying in January was under expectation. Rail buying within the last week brings the total for the season to 1,300,000 tons, compared with 1,700,000 tons a year ago. The only price changes are an advance of 20c. for rivets and 10c. for cold-rolled strip steel, prices for the two products now being $3.10 and $2.95. Chicago reports January as one of the best months, operating capacity increasing 10 per cent, to 90 per cent, for the Steel Corporation and 85 per cent for the largest independent. Railway contracts in sight exceed $100,000,000, including orders for 35,000 cars.

Unemployment Existent in Several Cities

Although the general labor situation in the building trades may be regarded as satisfactory, there are several slack spots. Unemployment in Philadelphia is highest since 1921, but despite this the ironworkers are on strike against the open shop. Relief is seen in a $400,000,000 program. Birmingham is another city where men in all crafts are out of work. In St. Louis, where there is considerable unemployment, wage increases are demanded by ironworkers, asbestos workers, roofers' helpers and common laborers.

Cleveland looks for a record year. In New Orleans price cutting has ceased among materials dealers. Dallas has a small surplus in all crafts, with conditions improving. Boston is optimistic except for industrial building. Railway shop workers have been granted increases by the New York Central, Norfolk & Western, and Pennsylvania railroads.

Demands of Labor

In New York 1,500 marble workers plan to strike unless an advance of $2 per day, to $14, and the five-day week are granted. New York electricians were recently granted a five-day week and a 10 per cent advance in wages, thus bringing the rate to $13.20 per day as of Feb. 1. Prior to the demand of the elctrical workers an agreement had been reached between the Building Trades Council and the Building Trades Employers Association to arbitrate the five-day week and higher wages after Jan. 1, 1930. Granting the electricians' demand has created some friction between the electrical contractors and the Building Trades Employers Association, to which they belong.

St. Louis ironworkers have presented demands for an increase of $2, to $14, for ordinary workmen and $1, to $15, for foremen, to be effective May 1.

In San Francisco twelve building trades have been granted increases of from 25c., to $1 per day. Reductions were made in wages of sash-and-door mill men, planing mill and cabinet workers, shop varnishers and polishers.

Bricklayers in Poughkeepsie will demand an increase of $2 per day, to $14, with a five-day week effective May 1. Bricklayers and stone masons of Toronto will receive an advance of 5c. per hour, to $1.30, effective May 1.

Public Financing Lowest Since 1919

State and municipal flotations in January totaled $69,766,000, the smallest figure for that month since 1919. The total for January, 1928, was $103,139,000. The decline is attributed to the refusal of many municipalities to offer their bonds at the prevailing prices. The *Bond Buyer's* index of municipal bond yields, based on market prices of bonds of twenty cities, was 4.17 on Jan. 1, compared with 3.87 a year ago. Some of the current offerings are listed in the table below:

		Interest Rate	Yield
Atlantic City, N. J.	$2,510,000	4½	4.40
Cook County, Ill., road and bridges	4,320,000	4	4.40@4.10
Mobile, Ala., water works	300,000	5	4.50
Oyster Bay, N. Y., sewers	530,000	4½	4.20@4.15
Portland, Ore., water	1,000,000	4	4.15
Rahway, N. J., school	277,000	4½	4.40@4.35
Rockland County, N. Y.	1,100,000	4½	4.25@4.10
Utica, N. Y.	830,000	4.20	4.20@4.05
Cuba, additional public works	10,000,000	5½	5.50
Hanover, Germany	4,000,000	6½	7.00

VALUE OF CONTRACTS BY SECTIONS IN THE UNITED STATES AND TOTAL FOR CANADA, JANUARY, 1929

Thousands of dollars (-000) omitted

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States Jan., 1929	United States Jan., 1928	Canada
Water-works	$116	$443	$15	$1,362	$801	$64	$2,801	$2,147	$73
Sewers	52	2,016	538	1,964	1,306	403	6,279	3,071	477
Bridges	.....	797	2,322	1,352	3,046	151	7,668	4,661	.....
Excavations, drainage, etc	.....	317	416	1,423	8,807	94	11,057	2,979	27
Streets and roads	908	3,394	5,954	3,844	12,247	4,833	31,180	26,781	340
Industrial buildings	2,150	56,874	1,098	11,086	1,840	4,600	77,648	21,015	1,490
Commercial buildings	23,566	69,800	9,064	22,229	11,772	13,034	149,465	95,993	7,350
Federal government	34	6,508	1,214	492	89	205	8,542	5,615	.....
Unclassified	247	16,209	332	8,559	60,669	16,177	102,193	35,722	1,490
January, 1929	$27,073	$156,358	$20,953	$52,311	$100,577	$39,561	$396,833	$197,984	$11,247
December, 1928	13,273	66,640	24,051	51,210	53,550	28,373	237,097	.....	20,829
January, 1928	17,340	72,804	19,077	40,280	31,681	16,802	197,984	.....	12,575

Current Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

Building Materials

PORTLAND CEMENT—Prices per bbl., quoted by manufacturers and dealers, delivered by truck to contractors, *without charge for bags*. Cash discount not deducted.

	Feb. 7, 1929	One Month Ago	One Year Ago
Atlanta	**$2.25**	$2.10	$2.45
Baltimore	2.65	2.65	2.50
Birmingham	2.60	2.60	2.40
Boston	2.45	2.45	2.05f.o.b.
Cedar Rapids (f. o. b.)	2.24	2.24	2.24
Chicago (f. o. b.)	2.05	2.05	2.05
Cincinnati (f. o. b.)	2.22	2.22	2.23
Cleveland (f. o. b.)	2.24	2.24	2.24
Dallas	2.15	2.15	2.05f.o.b.
Davenport (f. o. b.)	2.24	2.24	2.24
Denver	2.55	2.55	2.85
Detroit (f. o. b.)	1.95	1.95	1.90
Duluth (f. o. b.)	2.04	2.04	2.04
Indianapolis, (f. o. b.)	2.09	2.09	2.19
Jersey City	2.25@2.40	2.35	2.13f.o.b.
Kansas City, Mo.	**2.40**	2.20	2.10f.o.b.
Los Angeles	2.66	2.66	2.50
Milwaukee (f. o. b.)	2.20	2.20	2.20
Minneapolis (f. o. b.)	2.22	2.22	2.22
Montreal (f. o. b.)	1.41	1.41	1.41
New Orleans	**2.65**	2.35	2.07f.o.b.
New York	2.25@2.35	2.25@2.35	2.25@2.35
Peoria (f. o. b.)	2.22	2.22	2.22
Philadelphia	**2.40**	2.40	2.40
Pittsburgh (f. o. b.)	**2.05**	2.04	2.04
St. Louis	2.45	2.45	2.05f.o.b.
St. Paul (f. o. b.)	2.22	2.22	2.22
San Francisco	2.41	2.41	2.41
Seattle	2.70	2.70	2.65
Toledo (f. o. b.)	2.20	2.20	2.20

Current mill-prices per barrel, in carloads, without bags, f.o.b.:

Alpena, Mich.	$1.65	Leeds, Ala.	$1.65
Buffington, Ind.	1.80	Lehigh Valley District	1.75
Clinchfield, Ga.	1.65	Mason City, Ia.	1.80
Fordwick, Va.	2.05	Mitchell, Ind.	1.90
Hannibal, Mo.	1.90	North Birmingham, Ala.	1.45
Hudson, N. Y.	1.75	Richard City, Tenn.	1.85
Iola, Kan.	1.85	Steelton, Minn.	1.85
Kingsport, Tenn.	2.05	Universal, Pa.	1.80
La Salle, Ill.	1.90	Wyandotte, Mich.	1.70

SAND AND GRAVEL—Dealers' quotations per cu.yd. delivered. Weight of sand, 1¼ tons per cu.yd.; gravel, 1½ tons per cu.yd., unless otherwise specified in pounds.

	Gravel		Sand
	1½ In.	¾ In.	
Atlanta, per ton	$3.50	$3.50	$2.50
Baltimore, per ton	2.40	2.60	1.70
Birmingham (2,600 lb.)	3.00	3.00	2.65
Boston, per ton	**2.00**	2.00	1.50
Chicago	2.25	2.25	2.25
Cincinnati, per ton	1.90	1.90	1.60
Cleveland	*2.60*	*2.60*	2.50
Dallas	2.50	2.50	2.25
Denver (2,700 lb.)	1.80	1.80	1.30
Detroit (2,600 lb.)	**3.25**	**3.25**	**2.75**
Kansas City, Mo.	2.40	2.40	....
Los Angeles, per ton	2.15	2.15	1.30
Minneapolis (2,800 lb.)	2.25 ton	2.25 ton	1.00
Montreal, per ton	1.90	1.50	1.20
New Orleans (2,700 lb.) (2,500 lb.)	**3.75**	**3.75**	**2.75**
New York	3.25@3.50	3.25@3.50	2.00@2.25
Philadelphia, per ton	2.30@3.15	2.30@3.15	1.50@2.31
Pittsburgh, per ton	2.40	2.40	2.60
St. Louis, per ton	2.00	2.00	**1.65**@1.90
San Francisco (2,800 lb.)	1.75	1.75	1.50
Seattle (3,200 lb.) (2,850 lb.)	2.00	2.00	2.00

Note: New York gravel weighs 2,800@3,000 lb. and sand, 2,700 lb.

CRUSHED STONE—Dealers' quotations per cu.yd., delivered. Weight, 1½ tons per cu.yd., unless otherwise specified in pounds:

	1½ In.	¾ In.
Atlanta, per ton	$3.50	$3.50
Baltimore, per ton	2.75	2.85
Birmingham, Limestone	3.00	3.25
Boston, per ton	2.40	2.40
Chicago, Limestone	2.25	2.25
Cincinnati, per ton	2.50	2.50
Cleveland, per ton	*2.70*	*2.70*
Dallas	3.25	3.40
Denver, Granite (2,700 lb.)	2.50	2.50
Detroit, Limestone, per ton	**3.00**	**3.00**
Kansas City, Limestone, (2,450 lb.)	2.00	2.00
Los Angeles, per ton	*2.00*	*2.00*
Minneapolis, Limestone, per ton	2.25	2.25
Montreal, per ton	2.10	2.10
New York, Limestone	3.25@3.50	3.25@3.50
Philadelphia, Limestone, per ton	2.30@3.15	2.30@3.15
Pittsburgh, per ton	2.75	2.75
St. Louis, per ton (2400 lb. per cu.yd.)	1.90	1.90
San Francisco, Trap rock (2,400 lb.)	1.65	1.65
Seattle, (2,700 lb.)	1.90	1.90

CRUSHED SLAG—Manufacturers' quotations on crushed slag in carloads, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Sand
Birmingham, Ala.	$0.90	*$1.15*	$2.05	*$0.55*
Buffalo District	1.25	1.35	2.25	1.25
Cleveland, Ohio	**1.30**	**1.30**	....	1.30
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Youngstown District	1.30	1.40	2.00	1.30

HOLLOW TILE—Dealers' quotations on hollow building tile per block, delivered to contractors in lots of 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Atlanta	**$0.075**	**$0.104**	**$0.142**	**$0.189**	**$0.21**
Baltimore	**.105**	....	**.20**	....	**.26**
Birmingham	.09	.127	.174	.218	.261
Boston	.08	.105	.145	.185	.25
Chicago	.076	.104	.142	.182	.202
Cincinnati	.074	.105	.136	.175	.205
Cleveland	.064	.088	.128	.171	.19
Dallas	.096	*.12*	.1785	.284	....
Denver	.0975	.135	.175	.2125	.25
Detroit	.096	.132	.18	*.235*	*.281*
Kansas City	*.0525*	.077	.158	....	*.242*
Los Angeles	.085	.122	.175	.232	.285
Minneapolis	.0675	.0845	.131	.134	.1896
Montreal	.12	....	.22	....	.315
New Orleans	*.086*	.125	*.16*	*.212*	**.247**
New York	.0864	.1296	.162	....	....
Perth Amboy, N.J. (f.o.b.)	....	....	....	.252	.312
Philadelphia	.11	.145	.22	.27	.34
Pittsburgh	.068	....	.1175	....	.1726
St. Louis	.078	.105	.145	.175	.21
San Francisco	.108	.156	.255	....	....
Seattle	.08	.11	.18	....	....

BRICK—Dealers' quotations, delivered, per thousand are as follows:

		Paving	
	Common	3x8¼x4-in.	3¼x8¼x4-in.
Atlanta	*$15.25*	$38.00*	$45.00†
Baltimore	15.00	40.00	45.00
Birmingham	15.00	32.00*	36.00†
Boston	17.25	45.00	50.00
Chicago	12.00	42.00	45.00
Cincinnati	18.00	40.00	45.00
Cleveland	14@16	33.00	36.00
Dallas	**14.50**	35.00	.....
Denver, salmon	12.00	.....	.....
Detroit	15.50	35.50	38.50
Kansas City	**16.00**	.....	.....
Los Angeles	11.00	.....	.....
Minneapolis	13.50	.....	.....
Montreal	20.33	.....	.....
New Orleans	**16.50**	40.00*	50.50
New York	*15@18*	45.00	51.00
Philadelphia	17.00	40.00	46.00
Pittsburgh	17.00	40.50	45.00
St. Louis, salmon	13.00	40.00	45.00
San Francisco	14.50	40.00	45.00
Seattle	14.00	50.00	55.00

*2¼x8¼x4 in. †3x8¼x4.

LIME—Dealers' quotations, delivered to job:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
Atlanta	$27.50	$17.50	$2.30†	$2.10†
Baltimore	20.00	14.00	2.55†	....
Birmingham	22.00	16.00	3.00†	2.00†
Boston	21.00	14.50	3.80*	2.90*
Chicago	20.00	18.00	20.00‡	1.50†
Cincinnati	18.00	13.20	.....	13.20‡
Cleveland	20.00	16.00	2.50†	2.50†
Dallas	19.00	.....	.....	**18.00‡**
Denver	32.00	23.75	3.80*	3.00*
Detroit	19.20	14.80	2.20†	2.20†
Kansas City	24.00	13.00	2.75†	**2.75†**
Los Angeles	25.00	18.00	2.85†	17.00‡
Minneapolis	25.50	21.00	.....	1.70†
Montreal	21.00	21.00	.....	15.00‡
New Orleans	....	....	2.60	**1.60†**
New York	21.00@22.00	14.00@15.00	4.00@4.10*	3.15@3.25*
Philadelphia	22.00	15.00	....	....
Pittsburgh	21.00	19.00	18.00‡	17.00‡
St. Louis	24.00	18.00	2.75†	2.10*
San Francisco	27.50	20.00	.....	1.70†
Seattle, paper sacks	36.00	24.00	.....	**2.80†**

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡Per ton.

CONCRETE BLOCKS—Manufacturers' quotations on standard, 8x8x16-in., hollow, delivered to job, each:

Boston	$0.18@.20	Minneapolis, f.o.b.	**$0.13**
Brooklyn and Queens	15@.17	New Orleans	.22
Cleveland	.17@.18	Philadelphia	.18@.25
Denver	.22	Pittsburgh	.20
Detroit	.15	St. Louis	.18

SLATE—Roofing, f.o.b., quarry, Bangor, Pa., per square:

No. 1 Clear	$9.50@$13.00
No. 1 Ribbon	8.25 9.25
Medium Clear	8.00@ 9.50

(2½ in.)

Road and Paving Materials

PAVING STONE—Dealers' quotations, f.o.b., in carloads or in cargo lots, for granite blocks, 4x8x4-in., dressed:

Atlanta	$3.00 per sq.yd.
Baltimore	3.00 per sq.yd.
Boston	135.00 per M.
Chicago, 5 in.	3.25@3.90 per sq.yd.
Cincinnati	110.00 per M.
Cleveland	115@120 per M
Detroit, 5 in.	3.00 per sq.yd.
Kansas City	3.50 per sq.yd
Minneapolis, Sandstone	2.74 per sq.yd.
Montreal	104.75 per M.
New Orleans	2.75 per sq.yd.
New York, 5 in., Grade 1, 30 blocks per sq.yd	150.00 per M.
Philadelphia	125.00 per M.
St. Louis, 4x7 to 11 in.	**3.50** per sq.yd.
San Francisco, Basalt block, 4x7x8 in.	70.00 per M.

Current Prices of Construction Materials

Road and Paving Materials—Continued

WOOD-BLOCK PAVING—Dealers' quotations, f.o.b., in carloads:

	Size of Block	Treatment	Per Sq. Yd.
Atlanta	3½	Ib	$2.25
Boston	3½	Ib	2.40
Chicago	3½	Ib	2.10
Cincinnati	3½	Ib	2.35
Dallas	4	Ib	3.90
Kansas City	3½	Ib	2.50
Minneapolis	3½	Ib	2.75
Montreal	4	Ib	4.50
New Orleans	3½	Ib	2.30
New York	3½	Ib	2.70
St. Louis	3½	Ib	2.35

FLAGGING—Dealers' quotations, alongside dock, New York: Manhattan and Bronx, 4 ft. wide, 24c. per sq.ft.; Queens, 5 ft. wide, 20c. per sq.ft.

CURBBING—Dealers' quotations: *New York*: Bluestone, f.o.b. barge, New York, 5x16 in., rough, 90c. per lin.ft., cutting charges extra. *Birmingham*: Limestone, 5x18-in., f.o.b., $1.05 per lin.ft. *St. Louis*: Class "B" straight, 5x16-in., f.o.b., $1.00 per lin. ft.; roundings, $1.50 per lin.ft.

ASPHALT—Manufacturers' quotations per ton in packages (350-lb. bbls. or 425-lb. drums); also in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
Atlanta (Mexican)	$22.60	$18.40
Baltimore (Standard Oil, f.o.b. refinery)	21.75	17.75
Birmingham (Mexican)	27.00	23.00
Boston (Mexican)	24.50	18.25
Chicago (Texas)	24.50	21.30
Cincinnati (Kentucky Rock)		12.30
Cleveland	24.00	20.00
Dallas (Texas)	24.75	
Denver (California)	35.00	
Detroit (Mexican)	24.00	19.00
Kansas City, Mo. (Texas)	27.30	25.30
Los Angeles ("D" Grade, California, f.o.b. El Segundo)	18.00	12.00
Maurer, N. J. (Bermudez)	30.00	
Maurer, N. J. (Trinidad)	25.00	
Minneapolis, (Stanolind, f.o.b. Twin Cities)	29.10	20.10
Montreal (Imperial)	28.00	21.50
New Orleans (Texas)	24.00	21.00
New York (Texas)	22.50	18.50
Philadelphia (Mexican)	20.00	18.00
Pittsburgh (Standard Oil)	22@23½	16@18
St. Louis (Mexican)	23.50	19.50
San Francisco, (f.o.b. refinery, Oleum, Calif.)	18.00	12.00
Seattle, ("D" grade, California, f.o.b. Richmond refinery)	19.50	13.50

*At refinery.

ROAD OILS—Manufacturers' quotations, f.o.b., in tank cars, 8,000 gal. minimum, per gal.:

Birmingham, 40@50% asphalt	$0.0525
Birmingham, 50@60% asphalt	0525
Dallas, 40@50% asphalt	06
Dallas, 50@60% asphalt	06
New York, 40@50% asphalt (at terminal)	06
New York, 50@60% asphalt (at terminal)	06
St. Louis, 40@50% asphalt	0418
St. Louis, 50@60% asphalt	0418

Iron and Steel

PIG IRON—Producers' quotations, per gross ton, f.o.b.:

Birmingham, No. 2 fdry., silicon 1.75@2.25	$16.50@$17.00
Pittsburgh, basic, incl. freight ($1.76) from Valley	19.26

STRUCTURAL STEEL—Manufacturers' and dealers' quotations per 100 lb.:

	Shapes, 3 to 15-In.	Plates, ¼-In.
Birmingham, large mill lots, f.o.b.	$2.15	$2.15
Chicago, warehouse, delivered	3.10	3.10
Cleveland, warehouse, delivered	3.00	3.00
Dallas, warehouse, delivered	3.50	3.50
New York, warehouse, delivered, 250 to 3,999 lb.	3.30	3.30
Pittsburgh, large mill lots, f.o.b., (Jan. 31, 1929)	1.90	1.90
St. Louis, warehouse, delivered	3.25	3.25
San Francisco, warehouse, delivered	3.15	3.15

BARS, CONCRETE REINFORCING—Manufacturers' and dealers' quotations on bars rolled from billets, per 100 lb. for ½-in.:

Birmingham, large mill lots, f.o.b.	$2.15
Chicago, warehouse, delivered	2.30@3.00
Cleveland, warehouse, delivered	2.25@3.00
Dallas, warehouse, delivered	3.50
New York, warehouse, delivered, over 5 tons	2.85
Pittsburgh, large mill lots, stock lengths, f.o.b.	2.00
St. Louis, warehouse, delivered	3.15
San Francisco, warehouse, delivered	2.25

EXPANDED METAL LATH—Dealers' quotations per 100 sq.yd., painted, delivered to job in less-than-carload lots:

Lb. per Sq. Yd.	New York	Birmingham	Chicago	St. Louis	Dallas	San Francisco
2.2	$15.00	$19.00	$14.00	$18.00	$21.50	$16.00
2.5	16.00	20.00	15.00	19.00	24.00	17.00
3.0	17.50	22.50	16.50	21.00		19.50
3.4	20.00	24.50	18.00	22.50	30.00	21.50

WIRE REINFORCEMENT FOR CONCRETE—Manufacturers' quotations per 100 sq.ft. in carloads at mills; and dealers, delivered in lots of 10,000 sq.ft. or over; plain 4 in. by 4 in. mesh:

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse Delivery: New York	St. Louis	Dallas	San Francisco
032	22	$0.99	$1.01	$1.39	$1.30	$1.13	$1.22
049	28	1.26	1.29	1.76	1.70	1.38	1.55
068	35	1.54	1.58	2.18	2.10	1.67	1.91
093	40	1.98	2.03	2.79	2.65	2.00	2.46
126	52	2.45	2.51	3.45	3.30	2.55	3.03
153	68	2.92	2.99	4.13	3.95	3.15	
180	78	3.35	3.43	4.73	4.50	3.42	

STEEL SHEETS—Manufacturers' and dealers' quotations per 100 lb., base size:

	Blue Annealed No. 10	Black No. 24	Galvanized No. 24
Chicago, warehouse, delivered	$3.35	$3.80	$4.65
Cleveland, warehouse, delivered	3.25	3.60	4.45
New York, warehouse, delivered	3.90*	4.00	4.75
Pittsburgh, large mill lots, f.o.b.	2.10	2.85	3.60
St. Louis, warehouse, delivered	3.45	4.10	4.95
San Francisco, warehouse, delivered	3.35	5.80	5.40

*250 to 3,999 lb.

WIRE ROPE—Discounts from manufacturers' list price on regular grades of bright and galvanized, Eastern Territory, New York, and East of Missouri River:

	Base
Cast steel round strand rope	20%
Galvanized iron rigging and guy rope (add to list)	12½%
Galvanized steel rigging and guy rope	7½%
Plow steel round strand rope	35%
Round strand iron and iron tiller	5%
Special steel round strand rope	30%

Discount 5 points less than discount for Eastern territory: California, Oregon, Nevada, Washington, Wyoming, New Mexico, Colorado, North Dakota, Nebraska, Kansas, Oklahoma and Texas. Discount 10 points less than discount for Eastern territory: Arizona, Montana, Idaho and Utah.

RIVETS—Manufacturers' and dealers' quotations per 100 lb., ½-in., full packages:

	Structural	Boiler
Chicago, warehouse, delivered	$3.60	$3.60
Dallas, warehouse, delivered	4.75	4.75
New York, warehouse, delivered	5.00	5.00
Pittsburgh, large mill lots, f.o.b.	2.90	2.90
St. Louis, warehouse, delivered	3.75	3.75
San Francisco, warehouse, delivered	5.75	5.75
Seattle, warehouse, delivered	3.75	3.75

STEEL SHEETPILING—The manufacturers' base price, f.o.b., Pittsburgh, for large mill lots is $2.25 per 100 lb.

TERNE PLATE—I C, 8-lb. coating, 20x28-in., f.o.b., Pittsburgh mill, per package $11.20

SHIP SPIKES—Dealers' quotations per 100 lb., black, from warehouse stocks; galvanized are about $1.75 per 100 lb. higher:

	½-In.	⅝-In.	¾-In.
San Francisco	$5.55	$5.10	$4.95
Seattle	7.75	5.65	5.50

Pittsburgh mill base in lots of 200 kegs or more, $3.00 per 100 lb.

WIRE NAILS—Dealers' quotations per 100 lb. keg, base, delivered from warehouse stocks, also Pittsburgh mill base:

Pittsburgh Mill	Birmingham	Chicago	St. Louis	Dallas	San Francisco	Montreal
$2.65@$2.75	$3.30	$3.10	$3.05	$3.85	$3.35	$4.95

SCRAP—The prices following are, f.o.b., per ton, paid by dealers:

	New York Per Gross Ton	Chicago Per Gross Ton	Detroit Per Gross Ton
No. 1 railroad wrought	$12.50@$13.00	$15.75@$16.25	$15.00
Stove plate	9.25@9.50	15.00@15.50	10.50@11.00*
No. 1 machinery cast	15.00@17.00	17.50@18.00	13.00*
Machine shop turnings	8.25	10.00@10.50	9.00
Cast borings	7.00@7.25	13.00@13.50	10.50
Railroad malleable	13.00@14.00	19.00@19.50	14.00
Re-rolling rails	13.75@14.25	17.50@18.00	16.00
Re-laying rails, 56@60 lb.	23.00@24.00	23.00@25.00	
Heavy melting steel, No. 1	12.50@13.75	15.75@16.25	15.50
Iron and steel pipe	11.75@12.25	12.00@12.50	9.00

*Net ton.

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant-steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carload lots of 36,000 lb. or 18 tons:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.71*
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15†
Chicago	.34	Philadelphia	.32
Cincinnati	.27	St. Louis	.405
Cleveland	.19	St. Paul	.60
Denver	1.15†		

*Except iron or steel pipe and fittings. †Minimum weight on structurals, 60,000 lb.

Railway Materials and Supplies

STEEL RAILS—Manufacturers' quotations per gross ton, f.o.b., for large mill lots:

	Pittsburgh	Birmingham	Chicago
Standard openhearth rails	$43.00	$43.00	$43.00
Light rails, 25 to 45 lb.	36.00	34@36	34@36
Re-rolled rails	34@36	34@36	34@36

RAILWAY TIES—Dealers' quotations, f.o.b., for fair-sized orders:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
New York	Long-leaf sap pine, untreated	$1.10	$1.30
	Creosoted—prices on application		
Birmingham	Southern pine, untreated	1.10	1.25
	Southern pine, creosoted	1.60	1.75
Chicago	White oak, untreated	1.40	1.78
	Oak, empty cell, creosoted	1.80	2.40
	Oak, zinc treated	1.60	2.10
	Southern pine, creosoted	1.60	2.10
St. Louis	White oak, untreated	1.20	1.70
	Red oak, creosoted	1.45@1.60	2.05@2.10
San Francisco	Sap pine or cypress, untreated	1.00	1.50
	Douglas fir, green, untreated	.82	1.14
	Douglas fir, empty cell, creosoted	1.73	2.32
Montreal	Birch or maple, untreated	.75	1.25
	Birch or maple, creosoted	1.25	1.55

Current Prices of Construction Materials

Railway Supplies—Continued

TRACK SUPPLIES—Manufacturers' and dealers' quotations per 100 lb. f.o.b. Pittsburgh mill, for large mill lots, together with warehouse prices at other places named:

	Pittsburgh	Chicago	Birmingham	St. Louis	San Francisco
Standard spikes, ⅜-in. and larger	$2.80	$3.55	$3.50	$3.55@$3.70	$3.85
Track bolts	3.80	4.55	4.50	4.55@4.75	4.85
Standard section angle bars, splice bars or fish plates	2.75	3.40	3.50	.....	.....

Tie plates: Price at Pittsburgh and Chicago mills, $2.15 per 100 lb.

Pipe

WROUGHT-STEEL PIPE—Discounts from manufacturers' and dealers' standard lists:

	1 to 3-In. Butt Weld		2½ to 6-In. Lap Weld	
	Black	Galvanized	Black	Galvanized
Chicago, warehouse, delivered	54%	41%	51%	38%
Cleveland, warehouse, delivered	55½%	43½%	53½%	40½%
New York, warehouse, delivered	50%	36%	45%	32%
Pittsburgh, large mill lots, f.o.b.	62%	50½%	59%	47½%
St. Louis, warehouse, delivered	49%	36%	46%	33%

CAST-IRON PIPE—Prices of U. S. Cast Iron Pipe & Foundry Co., per net ton, for bell and spigot pipe, Class B and heavier, f.o.b., in large mill lots, 1,000 tons:

	4-In.	6-In. and Over
Birmingham mill	$41.00	$38.00
Burlington (N. J.) mill	41.00	38.00
Chicago	49.20@50.20	46.20@47.20
New York	43.60	40.60
Pittsburgh	49.50	46.50
St. Louis	46.60	43.60
San Francisco	51.00	48.00

Gas pipe and Class A, $3.00 per ton extra.

SEWER PIPE—Dealers' quotations, delivered, in cents per foot, for standard pipe; 6, 8 and 12-in. are single strength and 18, 24, 30 and 36-in. are double strength:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	$0.20	$0.34	$0.75	.....	.....	.....	.....
Baltimore	.16	.30	.58	.....	$1.93	.....	$6.50
Birmingham	.25	.40	.65	$1.50	2.75	$3.90	5.83
Boston	.175	.285	.53	1.25	2.10	3.25	5.75
Chicago	.16	.28	.54	1.25	2.25	4.75	6.00
Cincinnati	.144	.224	.432	.80	1.44	2.304	4.8175
Cleveland	.18	.28	.54	1.30	2.34	4.68	7.18
Dallas	.256	.42	.794	1.70	3.00	.....	.....
Denver	.161	.23	.414	.816	1.44	.....	.....
Detroit	.18	.28	.6075	1.50	2.70	5.12	7.91
Kansas City	*.15*	.29	.52	.....	*1.80*	3.90	.....
Los Angeles	.21	.2825	.51	1.186	2.03	3.39	5.09
Minneapolis, cars	.1575	.25	.45	.85	1.80	3.75	4.94
Montreal	.36	.53	.78	1.48	2.75	4.20	.....
New Orleans	*.18*	*.30*	*.54*	1.02	1.95	.....	.....
New York	.185	.29	.56	1.35	2.45	4.60	7.07
Philadelphia	.117	.182	.351	1.025	1.845	3.60	5.6375
Pittsburgh	.1035	.161	.3105	.90	1.62	3.024	4.8175
St. Louis	.1645	*.182*	.468	1.092	1.872	3.65	4.80
San Francisco	.21	.30	.54	1.26	2.16	3.60	.....
Seattle	.22	.30	.54	1.26	2.16	3.60	.....

CLAY DRAIN TILE—Dealers' quotations, delivered, per 1,000 lin.ft.:

Size, In.	New York	Birmingham	St. Louis	Dallas	San Francisco	Seattle
3	$40.00	$45.00	$50.00	.....	.....	$40.00
4	45.00	56.00	50.00	$73.00	$67.50	60.00
5	50.00	80.00	85.00	110.00	86.25	.....
6	78.00	105.00	85.00	118.00	112.50	90.00
8	130.00	175.00	195.00	150.00	187.50	.....

Miscellaneous

LINSEED OIL—Dealers' quotations on raw oil, f.o.b., in 1- to 4-bbl. lots, per lb.:

New York...$0.108 Chicago...*$0.11* Minneapolis...*$0.118*

WHITE AND RED LEAD—Dealers' quotations per 100-lb. keg, base price, f.o.b., New York: White, dry or in oil, $13.25; Red, dry, $13.25; Red, in oil, $14.75.

CHEMICALS—Water and sewage treatment chemicals, round lots in the New York market:

Sulphate of aluminum, iron free, in bags, per 100 lb	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb	*5.00*
Soda ash, 58%, in bags, per 100 lb	1.32
Chlorine, liquid, cylinders, per lb	.05 @ .08
Bleaching powder, in drums, f.o.b. works, per 100 lb	2.00

MANILA ROPE—The number of feet per pound for the various sizes is as follows: ½-in., 8-ft.; ⅝-in., 6-ft.; ¾-in., 4½-ft.; 1-in., 3½-ft.; 1¼-in., 2-ft., 10-in.; 1½ in., 2-ft. 4 in. Following are dealers' quotations per pound for ½-in. and larger, delivered in 1,200-ft. coils:

Atlanta	$0.25	Kansas City	*$0.28*
Baltimore	.22½	Los Angeles	.25
Birmingham	.26	Minneapolis	.22
Boston	.25	Montreal	.24½
Chicago	.20	New Orleans	.23½
Cincinnati	.21	New York	.21
Cleveland	.21	Philadelphia	.24
Dallas	.18	San Francisco	.20½
Denver	.23	Seattle	.20½
Detroit	.24½	St. Louis	.19½

ROOFING MATERIALS—Dealers' quotations, f.o.b., New York, to contractors in carloads:

Asphalt felt, per 100 lb	*$3.00*
Tar felt, per 100 lb	3.27½
Asphalt coating, per gal	.3½
Tar pitch, in 350 lb. barrels, per ton	*29.00*

PREPARED ROOFINGS—Dealers' quotations to contractors, in carloads, f.o.b. New York.

Single shingles, slate finish, sufficient to cover 100 sq ft	$6.12½
Strip shingles, 4 in 1, hexagonal shape, with Underwriters' label	5.00
Slate surfaced roofing in rolls weighing 85 to 90 lbs	2.50

WINDOW GLASS—United inches 25, bracket size 6x8 to 10x15, single or double thickness, discount from jobbers' list (Sept. 15, 1928), at New York warehouses:

AA .....83% A .....86% B 88%

EXPLOSIVES—Manufacturers' quotations per pound for dynamite delivered in small lots:

	Gelatin 40%	Gelatin 60%		Gelatin 40%	Gelatin 60%
Atlanta	$0.22½	$0.25	Los Angeles, f.o.b.†	$0.1875	$0.2225
Baltimore	.215	.2375	Minneapolis	.1967	.2173
Birmingham	.22	.245	Montreal	.195	.22
Boston	.23	.25	New Orleans	.235	.26
Chicago	.195*	.22*	New York	.26‡	.2825‡
Cincinnati	.22	.245	Philadelphia	.215	.24
Dallas	.2375	.295	St. Louis	.215	.235
Denver, f.o.b.	.1925	.215	San Francisco	.1625	.1925
Kansas City, Mo.	.2025	.2225	Seattle	.16	.185

*Quantities above 500 lb. but less than a ton. †San Fernando Arsenal. ‡Special gelatin in case lots.

Lumber

Prices Are Per Thousand Feet, Board Measure

San Francisco—Dealers' quotations on rough Douglas fir, No. 1 common, at yards; for delivery to contractor at site of job, add $1.50 to $5 per M. ft.:

	10-16-18 and 20 Ft.	22 and 24 Ft.
3x3 and 4	$28.00	$29.00
3x6 and 8	28.00	29.00
3x10 and 12	28.00	29.00
3x14	31.00	33.00

Chicago—Dealers' quotations, f.o.b., in carloads, per M. ft. b.m.; for delivery to job from stock, in truckloads, add $10 per M. ft.:

	20 Ft. and Under No. 1 Long-Leaf Yellow Pine	Up to 32 Ft. No. 1 Douglas Fir
3x4 to 8x8	$41.00	$42.00
3x10 to 10x10	48.50	42.00
3x12 to 12x12	58.50	42.00
3x14 to 14x14	70.50	43.00

New York—Quotations per M. ft., b.m., wholesale, for long-leaf, yellow-pine timbers, No. 1 common, rough, in quantities of 35,000 ft. or more, within lighterage limits:

	20 Ft. and Under	22-24 Ft.
3x4 to 8x8	$43.00@$45.00	$44.00@$46.00
3x10 to 10x10	50.00@ 52.00	51.00@ 55.00
3x12 to 12x12	57.00@ 59.00	58.00@ 60.00
3x14 to 14x14	65.00@ 67.00	66.00@ 68.00

Other Cities—Dealers' quotations, delivered, per M.ft., b.m.:

	8x8-In. x 20 Ft. and Under, Rough				3x12 to 12x12-In. 20 Ft. and Under, Rough	
	Pine*	Fir†	Hemlock	Spruce	Pine*	Fir†
Atlanta	$45.00	.....	.....	.....	$65.00	.....
Baltimore	36.00	$50.25	$54.00	$61.00	75.00	$50.25
Birmingham	45.00	.....	.....	.....	60.00	.....
Boston	48.00	47.00	47.25	47.50	57.00	51.00
Cincinnati	38.00	49.00	47.00	47.00	*40.00*	53.00
Cleveland	65.00	65.00	.....	.....	65.00	65.00
Dallas	65.00	56.00	57.50	.....	65.00	57.50
Denver	.....	59.00	.....	.....	57.00	55.00
Detroit	65.00	*50.00*	.....	.....	67.50	*50.00*
Kansas City, Mo.	42.80	39.75	.....	.....	57.50	39.75
Los Angeles	.....	44.00	.....	.....	.....	44.00
Minneapolis	55.00	50.25	37.25‡	.....	55@57	50.25@51.75
Montreal	50.00	55.00	.....	.....	49.00	48.00
New Orleans	50.00	*46.00*	.....	44.00	67.00	*63.00*
Philadelphia	52.00	35.00	42.00	40.00	55.00	35.00
St. Louis	46.00	39.00	.....	.....	55.00	40.50
Seattle	.....	22.50	.....	.....	.....	22.50

	1x10 In. x 16 Ft. and Under, Rough			2x10 In. x 16 Ft. T. & Gr.	
	Pine*	Fir†	Hemlock	Pine*	Fir†
Atlanta	$60.00	.....	.....	$47.50	.....
Baltimore	56.00	$45.00	$45.00	35.00	$48.00
Birmingham	36.00	.....	.....	43.00	.....
Boston	44.00	42.75	42.00	48.00	47.50
Cincinnati	35.00	40.00	33.00	35.00	48.00
Cleveland	60.00	55.00	.....	65.00	58.00
Dallas	60.00	.....	.....	.....	.....
Denver	.....	50.00	.....	.....	51.00
Detroit	42.00	42.00	.....	45.00	*45.00*
Kansas City, Mo.	50.50	45.75	.....	44.75	36.75
Los Angeles	.....	38.00	.....	.....	57.00
Minneapolis	50.00	44.00	38.75‡	50.00	45.00
Montreal	45.00	48.00	40.00	85.00	70.00
New Orleans	*43.00*	*40.00*	.....	50.00	*46.00*
Philadelphia	55.00	36.50	36.00	52.00	36.50
St. Louis	42.50	39.00	38.00	38.00	35.00
Seattle	.....	20.00	.....	.....	22.00

*Long-leaf yellow pine. †Douglas fir. ‡On cars

PILES—Dealers' quotations per lineal foot, pine, with bark on, f.o.b., New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41